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PARATHYROIDISM*

PAUL T. LLOYD

Professor of Radiology

From the Department of Radiology.
Osteopathic Hospital of Philadelphia

PARATHYROIDISM (hyperparathyroidism, hypercalcemia), in a word, implies imbalance and abnormality of calcium and phosphorus metabolism resulting from hyperplasia, tumor, or hypertrophy of the parathyroid glands. Pathology of the parathyroid, affecting as it does calcium-phosphorus metabolism, in turn produces changes in the osseous skeleton and impaired function of the muscular apparatus, the urinary tract, and the gastrointestinal tract. Most characteristic of all the changes wrought in the body by parathyroidism are those affecting the bony structures. Such changes are characteristically presented in the typical case of von Recklinghausen's osteosis (osteitis fibrosa cystica).

Of particular interest to the orthopedist are the osseous disorders brought about by parathyroidism. This paper will concern itself chiefly with those changes common to the bony skeleton, paying strictest attention, therefore, to osteosis fibrosa cystica, which has, during recent years, been proven to exist as a result of parathyroid pathology.

It is generally accepted as being true, today, that the function of the parathyroid glands is to regulate growth and maintenance of bone, maintain a normal blood calcium level, to regulate the ionized calcium of blood, to provide muscle and nerve irritability, and in an indirect manner affect the permeability of cell membranes. These varied and highly important activities are brought about through the agency of hormonal influence. It will be readily perceived how, in the presence of hyperplasia or adenoma of a parathyroid, an excess of the hormone (parathormone) produced will result in alteration of calcium metabolism and, in turn, a disturbance in the serum phosphorus and phosphatase values.

So-called hyperfunction of the parathyroid glands is most often due to hyperplasia or to adenoma. In the presence of either abnormal state, increased mobilization of calcium occurs, the bony skeleton undergoing rarefaction due to the withdrawal of stored calcium and phosphorus. The blood serum calcium level becomes elevated (hypercalcemia), the serum phosphorus lowered, while both serum and urinary phosphatase fractions are increased. Extensive bony changes are common features characterized by a generalized malacia accompanied by the formation of bone tumors and the development of bone cysts.

* Paper presented before the Orthopedic Conference at the Detroit Osteopathic Hospital, Detroit, Michigan, February 27, 1941.
Etiology

Current opinion as expressed in present day literature places stress on the possible causes of parathyroid adenoma and parathyroid hyperplasia. In the former condition (adenoma), the exact etiology is definitely obscure. It is believed by many that adenomatous changes result from embryonic cell rests. Parathyroid hyperplasia, according to some investigators, is the direct result of alteration in the parathyrotropic fraction due to an existing "pituitary disorder" (Albright quoted by Wolf). Vitamin D deficiency is known to induce parathyroid hyperplasia, and it may be that in the presence of already existing embryonic cell variations, vitamin D deficiency provides the exciting factor necessary for the development of adenoma, through active cell growth and proliferation. Theoretically at least, osteopathic reasoning relative to the cause of diseased body processes would appear to have a just place in a discussion of the causes of parathyroidism. One has but to realize the vascular and nerve supply to the glands, to perceive that disturbance or alteration in these anatomic factors might well result in abnormal cell metabolism and growth. However, this etiologic possibility in parathyroidism, as in many other disorders, must be regarded at present from a purely theoretical viewpoint.

Parathyroidism may occur in either sex and has been found to affect both young and old, but probably is most common in women between thirty and sixty years of age.

Pathology

The parathyroid lesion most often encountered is tumor involving usually but one gland, though parathyroid adenomas have been demonstrated in two glands upon occasion. The adenomatous gland is frequently difficult to identify at surgical exposure since oftentimes the adenoma itself is small, being concealed by the capsule of the gland. Location of the adenoma may be rendered more difficult when situated in an aberrant parathyroid. Tumors as large as a walnut have been demonstrated in contra-distinction to those of minute size. The adenoma may be of the simple, non-secreting type, or it may be a toxin secreting tumor, the latter form being encountered when generalized osteotic decalcification is present in the bony skeleton.

Altered function of the parathyroid, as in the case of adenoma or hyperplasia, results in the production of an excessive amount of parathormone which, when present in the circulation, results in an elevation of the blood calcium and a decrease in blood phosphorus. As pointed out by Schaffer, the calcium content of the blood, in parathyroidism, is in inverse ratio to the phosphorus content.

Normally, the blood serum calcium level is from 8.0-10.0 mg. per cent, the normal phosphorus level is from 3.5 to 4.0 mg. per cent, and the phosphatase 3-4 Bodansky units. In parathyroidism the three aforemen-
tioned blood values are 12.0-25.0 mg. per cent, 1.0-2.7 mg. per cent, and 12-20 Bodansky units respectively (increased osteoblastic activity). Urinary calcium and phosphorus are well above average (Wolf).

The muscular apparatus suffers a loss of tone, and muscle weakness is frequently encountered as an early finding. Change in the muscular structures may be explained on the basis of a reduction in the excitability of muscle tissue and as well a retardation in the transmission of impulses traveling over the nerves to the neuromuscular system. (Neuromuscular activity is definitely lowered by an increase in blood calcium. A directly opposite effect is present in tetany where decreased blood calcium and increased blood phosphorus are found.)

The marked increase in blood calcium, together with the elimination of both calcium and phosphorus in the urine, leads to the production of urinary tract calculi, and likewise to secondary deposits of calcium in other parts of the body, namely, the smaller arteries, skin, spleen, stomach, heart, thyroid gland, and lungs. In approximately 33 per cent of the cases of parathyroidism there have been found deposits of calcium in the kidneys with and without frank calculus formation. The development of calculus may precede or follow evidence of the disease in the bony skeleton. Renal function may be impaired to a striking degree due to inflammation occurring in the renal tubules. The kidneys may become contracted and display fibrosclerotic changes.

Perhaps the most striking abnormality is found in the osseous parts. The mobilization of calcium from the skeletal storehouse results in bone malacia. The bone may become so soft as to be readily cut with a knife. The long bones, particularly those of the lower extremities, become bent and bowed, leading to the production of spontaneous fractures. The bony pelvis is involved early and the vertebrae characteristically increase in biconcavity, resulting in the typical malacic "fish spine." Not infrequently, compression fracture of the spine results from almost insignificant trauma.

The first change in bone is that of lacunar resorption with increased osteoclastic activity present. The haversian canals are widened and increased in size. Fibrous tissue replacement of normal bone is a progressive feature, the fibrous metaplasia exciting inadequate osteoblastic reaction resulting in new bone. Osteoclasia is greatly increased, so likewise is osteoblastic activity. However, the former process appears to be predominant.

Between the fibrous tissue deposits, cysts form which may be located in the endosteum and medullary portions of the bone, and may even be found in the subperiosteum.

Benign giant cell tumors may develop as foci of various sizes. Being nonencapsulated, these tumors may merge with the surrounding bone. When present, they most often are found in the ends of the long bones, ribs, and mandible. They occur only in the presence of cancellous bone and may disappear after parathyroidectomy.
One of the earliest symptoms noted by the patient handicapped by parathyroidism is bone tenderness accompanied by pain. At first, bone tenderness and pain are not severe; but gradually and progressively they become more marked in intensity. At the onset, the character of the pain may lead to a diagnosis of "rheumatism," or arthritis. However, the increasing severity of this symptom causes the patient and physician alike to seek out a more satisfactory explanation for the unrelenting complaint. Not infrequently the pain is of the low back type, extending to the lower extremities in sciatic distribution—the "back of the leg pain" so well noted by Ballin.

Other symptoms and signs are those of muscle weakness, frequent falls, impairment of gait, spontaneous fractures, and bony swellings about the jaws, limbs, and extremities. Kyphosis, scoliosis, and loss of height due to vertebral involvement occur; and when the renal phases of the disease are of a high order, polyuria, renal colic, or symptoms of nephritis are present.

Cases of parathyroidism have been recorded where the symptoms and signs pointed to disease of the gastro-intestinal tract. In these instances, nausea, vomiting, and anorexia accompanied by sharp abdominal pain were noted. Constipation has also been an accompanying complaint.

**Diagnosis**

In but an exceedingly small number of cases of parathyroidism has it been possible to palpate the tumor. Therefore, local evidence of parathyroid disease will be lacking in the vast majority of instances.

The means at hand which offers the greatest opportunity for diagnosis is the roentgen ray. Today, the patient complaining of one or more symptoms comprising the parathyroid syndrome will most likely be referred for roentgenologic examination. Therefore, it becomes necessary for the roentgenologist to be well informed concerning parathyroidism, and to make certain that his examination is complete.

Radiographic examination of the bony skeleton in osteosis fibrosa cystica reveals demineralization with increased radiability of bone, assuming generalized and usually widespread involvement. Cysts are characteristically present.

Examination of the skull shows thickening of the calvarium (inter­tabular) with loss of sharpness of the marginal osseous relief. The cranial bones appear granular and decreased in density, with interposed and scattered areas of increased density. Cystic changes are present as a rule.

The long bones show thinning of cortex with like changes observed in the trabecular structure. The cortex is expanded, and marginal relief of the bones is lost as to sharpness of definition. Due to the malacic changes, the weight-bearing extremities bend and become bowed, particularly in the long standing and advanced cases. Areas of bone resorption
and cystic change are also encountered. Giant cell tumors are apt to be present, and fractures are common. The fractures heal and unite readily without an overabundance of callus.

The vertebrae may or may not display the typical alterations described as the "fish spine." In a typical case, the vertebral bodies show exaggerated bi-concave relief; and there is an attendant increase in width of the translucent disc spacings. Vertebral compressions with or without known trauma are commonly seen in osteosis fibrosa cystica and, as a rule, are located in the lower dorsal and upper lumbar regions. The vertebral bodies always display evidence of demineralization with multiple cystic zones present in the spongiosa. Spinal curvature results, usually in the form of dorsal kyphosis and lumbar lordosis. The compression and narrowing of the vertebrae produces a stooped, round-shouldered patient, exhibiting a slow but progressive loss in height.

The pelvis may be the site of early and pronounced osseous changes. The replacement of normal bone by varying degrees of fibrosis results in both nontrabeculated and trabeculated structure interposed by cysts. As in the other osseous regions, profound demineralization is evident. Pelvic fractures are not uncommon.

The ribs and extremities, the former particularly, become decalcified and show cortical expansion and increased radiability.

Renal calculi are frequently demonstrated during examination of the abdomen, and when seen accompanied by bony changes in the spine and pelvis, serve to direct the radiologist in the examination of the other bony parts.

Differential Diagnosis

**Osteosis deformans** (Paget's Disease). This disease, of unproven origin, occurs in middle age, usually at forty to sixty years of life. It is, as a rule, selective for certain areas of the skeleton in contra-distinction to the generalized bone changes common to osteosis fibrosa cystica. In Paget’s osteosis, the cortex is thickened, the medulla narrowed, and the bone presents a patchy relief at radiographic examination. Small cystic lesions are usually present, and the bones become deformed. The skull assumes a more or less typical "cotton wool" or "nigger wool" appearance.

The parathyroids are not affected in Paget's disease, and the blood calcium maintains a normal level though the blood phosphatase is markedly elevated.

Many present-day investigators believe Paget's disease to be of parathyroid origin, contending that von Recklinghausen’s disease and Paget’s disease are identical and that they represent different stages of the same disease.

**Osteomalacia.** This condition is most common to the adult female, being encountered in pregnancy, or later during the puerperium. It is a chronic disorder. The bones tend to be irregular in contour and outline, and they are diminished in radiodensity. Angular deformities are com-
mon; and when fracture occurs, poor callus and osteogenetic reactions are noted. The bony cortex is found to be irregularly atrophied and the medulla is widened. The skull usually escapes involvement.

The serum phosphorus is low, the phosphatase elevated, while the serum calcium may range from low to normal.

In this disease, there is defective absorption of calcium; osteoid tissue is formed, but fails to calcify due to a lack of vitamin D.

Rickets. In the young, rickets may give difficulty of differentiation. Radiographic examination, however, usually shows changes in the epiphyses which are characteristic; and, as well, other clinical signs of rickets make possible its differentiation from osteosis fibrosa. The blood calcium favors a normal level in rickets.

Focal Osteosis Fibrosa Cystica. This is a rather common condition, the usual findings being a localized osteosis fibrosa involving one or two bones, the remainder of the bony skeleton being normal. The accidental or intentional demonstration of a focal osteosis fibrosa should be followed by roentgenological investigation of the rest of the skeleton to completely differentiate monostotic and polyostotic processes. In focal osteosis fibrosa cystica, the blood calcium level is normal.

Multiple Myeloma. Myelomas are most common in males, occurring usually after forty years of age. Roentgenologic examination reveals the presence of multiple osteolytic areas in medullary location, possessing a punched-out appearance. The skull, ribs, sternum, and vertebrae show early involvement as a rule. Generally, there is expansion of the involved bone with cortical destruction following. The margin of the lesions is somewhat irregular in contour and gives the bone a moth-eaten appearance. The disease assumes progressive characteristics, and deformity producing fractures are rather common.

The serum phosphorus is normal; and, as a rule, the serum phosphatase remains stable. The Bence-Jones test is positive for proteinuria in from 35 to 50 per cent of all cases.

Biopsy will serve to complete the differential diagnosis in any questionable case.

Carcinoma. Osteal carcinoma is always metastatic and always exhibits progressive destructive characteristics violating the cortex with no visible indication of bone expansion. The metastatic lesions frequently exhibit a tendency to involve the bone first about the region of the nutrient vessels, particularly when the long bones are affected (this is well demonstrated in metastatic renal carcinoma). As a rule, the extremities below the elbow and knee are not involved, though metastatic carcinoma has been found in the distal extremity bones (Downs). In carcinoma, the calcium and phosphorus are not markedly altered.

Treatment

Briefly, there are at present but two forms of treatment available. The first is surgical, with removal of the parathyroid tumor. When the
adenoma is successfully located and its removal effected, the results are most startling. The pain disappears at once, and recalcification of the involved bones takes place (usually six to eight weeks after parathyroidectomy). The cysts are found to organize and solidify, and the giant cell tumors are replaced by bone approaching average quality.

The second plan of treatment is by irradiation. This treatment for the greater part as yet "untried" has, nevertheless, demonstrated itself to be of value in the treatment of osteosis fibrosa cystica. Merritt and others have established clearly the usefulness of radiation therapy in this disease, and their reports point definitely to the effectiveness of roentgen therapy directed to the parathyroid region. Merritt reported the early relief of pain with recalcification of bone. A greater number of cases treated and carefully recorded will permit of a more accurate estimate of the value of irradiation in the treatment of osteosis fibrosa cystica.

Discussion

At this particular time there is much yet to be learned relative to the exact etiology of parathyroidism. What is the exciting factor which results in the primary parathyroid instability and leads to hyperplasia and adenoma? Is it a vitamin deficiency, a pituitary hormone imbalance, or may it be of vegetative origin? Will research clearly establish the "cell rest" theory, or will the future disclose the causative factor as being a neurovascular disorder of vertebral or central origin? These and many other questions arise to confuse the present-day students who claim an interest in endocrinology, orthopedic surgery, or radiology. However confusing they may be, these questions serve to prompt the physician to further his studies and at the same time impel him to encourage and promote continuing investigative effort and scientific medical research.

Summary

A brief review of some of the salient facts concerning parathyroidism has been prepared with particular attention paid to the clinical and radiological findings in osteosis fibrosa cystica.

Attention has also been directed to the differentiation of this condition from certain other diseases which at times offer difficulty to the orthopedist and radiologist.

Reference has been made to the present-day treatment of parathyroidism.

Bibliography


A REVIEW OF SOME OPERATIVE INJURIES TO THE URINARY TRACT

H. Willard Sterrett
Professor of Urology

IN DISCUSSING the subject of injuries to the urinary tract, it should be understood that these accidents are those which occur in civilian practice and arise as complications of some surgical or diagnostic procedure. It is for this reason that we are reversing the usual order of discussion and beginning with the kidney.

Injuries of the Kidney

Wounds of the kidney, other than rupture, are extremely rare. Even in military practice, they are not as frequent as one would suppose; although in this present war, due to the enormous use of fragmentation bombs, there has been a higher incidence than in previous wars. When such condition occurs as a surgical accident, with which we are concerned, it is usually obvious; and repair is undertaken immediately. Further, when wounds do occur, they are usually confined to the ureter. Hermann reports a case in which complete division of the tube had occurred during a pyelolithotomy, the ureter being torn completely across about one inch below the pelvis. It was not until urinary fistula resulted that the true state of affairs was found. It was ultimately cured by removal of an entirely nephrotic kidney.

Injuries of the Ureter

It must always be borne in mind that nature sometimes plays pranks, and that a congenital or an acquired malposition of the ureter invites a surgical wounding, even in a spot sometimes as remote as a hernial orifice. Ross and Taylor discussed ureteric injuries incident to herniorrhaphy. Corliss, in 1904, had collected 11 cases, 6 of which occurred during operations for inguinal, and 5 for femoral hernia.

Surgical injuries of the lower portion of the ureters are more common, ligation unquestionably being the most frequent. Unilateral division, either intra- or extra-peritoneal, may occur. Excisions, instrumental rupture by catheter, etc., crushing with clamp, perforation with a needle, denudation, and laceration of the ureter, either unilaterally or bilaterally, are reported.

The majority of unilateral injuries of the ureter occur incidental to operations on the bladder and the female pelvis. Undoubtedly, ligation is the most frequent accident, while crushing with clamp, excision, and incision happen less frequently. In dealing with carcinoma of the uterus by hysterectomy, we find the most likelihood of ureteric damage. Wertheim injured the ureter in 10 per cent of a series of 500 radical hysterectomies.
and undoubtedly the accident occurs more frequently than the literature would suggest.

Complete unilateral occlusion in an uninfected case is usually followed by a mild hydronephrosis and, in a comparatively short time, by renal atrophy. If fistula results following such ligation, it is either due to necrosis at the site of the ligation or the spontaneous rupture of a dilated tube.

Incision, or partial excision of the ureter, if not repaired, leads to extravasation of urine which in most instances is discharged through the vagina or the abdominal incision. Intraperitoneal extravasation may or may not start an active peritonitis.

Unfortunately, such accidents, while of a serious nature, too frequently are not recognized until symptoms arise which would cause one to suspect them. When injuries are discovered at the operation they may or may not demand an immediate repair. If the ureter has been stripped of its blood supply and a clamp applied to the area so stripped, it is almost always certain that fistula will result. According to Furness, the clamping of a denuded ureter calls for an immediate ureterovesical anastomosis. When ligatures have been applied around the ureter and recognized at the time, the mere removal of a ligature from an otherwise uninjured ureter may suffice. Sampson reported five cases in which such immediate religation was done, and there were no complications following. If the ureter is sectioned, it may be repaired if possible. If plastic repair is impractical, as for instance, when a large amount of the ureter has been excised, one may ligate the stump of the ureter and trust that, if the kidney be normal, there will be spontaneous death of this viscus. An alternative to this is the transplantation of the ureter into the bowel, or to the skin.

Injuries which are discovered postoperatively present a surgical problem somewhat different from those found at operation. As stated above, unilateral ligation unquestionably remains undiscovered in many instances; and the kidney dies with little or no systemic reaction. If the mishap be discovered shortly after the surgical procedure, the question of untying the ligature is raised. It would seem, in principle, that re-operation is not advisable provided the opposite kidney functions normally and the patient is symptomless. It must be remembered that union and obliteration of the lumen of the ureter will take place in about a week; and it has been said that while functional restoration may take place within three weeks following occlusion in the experimental animal, this is not the case in humans. Absorption of the ligature may occur, but certainly it would not be wise to await this possibility when the necessity of re-establishing drainage is manifest.

The usual indication of ureteric injury is the establishment of fistula with the urine escaping by way of the vagina or wound. We have had one case of ureteric injury by needle and partial inclusion by ligature with resulting fistula which closed following ureteric dilatation, but the majority necessitate surgery. While attempts at plastic repair may be successful,
provided there be a sound kidney on the opposite side, in by far the majority of instances nephrectomy is the wisest and safest procedure. This is certainly so in a long standing case in which the kidney is dilated and reduced in function, and probably infected.

Bilateral injuries, strangely enough, as a rule are not discovered at surgery; and not until these patients develop uremic symptoms is the accident recognized. Such symptoms may occur in twenty-four hours, or may be delayed for seventy-two hours or more. A lesson to be learned from this is that any patient, following hysterectomy or other pelvic operation, who has not passed any urine in twelve hours should be catheterized. With the finding of an empty bladder, an immediate study should be made to determine the cause. We question very much the use of the urogram as of much value, due to the fact that the kidney would without doubt fail to secrete the dye. In several cases, attempts have been made to dilate cystoscopically. Certainly, if cystoscopy or other method makes a diagnosis possible, it may be possible to de-ligate and establish the drainage in the proper manner. This is surgery of choice, although a nephrostomy may save the patient's life and further surgery be done at a later date. Mortality is somewhat higher than 50 per cent.

Various methods of ureteric repair and anastomosis have been devised. Probably the method of Curtis is the most simple and easily accomplished. On discovery of the ureter severance, a ureteric catheter, as large as the ureter will comfortably permit, is passed into the ureter downward into the bladder, and upward for three or four centimeters toward the kidney. The ureter is then sutured end to end by fine silk or catgut, using interrupted sutures and not penetrating into the mucosum. On completion of this anastomosis a small opening into the ureter is made above the repair and another catheter is passed into the renal pelvis. This is then brought out through the flank through a stab wound and drains the kidney until union has taken place below. The flank wound is closed with customary drainage. At the end of ten days, both catheters are removed, the one in the bladder with the aid of the cystoscope.

Injuries of the Bladder

Wounds of the bladder are not commonly found, they being also primarily in the realm of war surgery. Despite this, however, damage to the bladder does occur in civilian practice often enough to command our attention, particularly when this organ is diseased. It is possible for a cystoscope to puncture the bladder; the use of the lithotrite has on more than one occasion torn it. The increasing use of the resecting loop for prostatic hypertrophy is causing an increasing number of cases of damage to the bladder by over-ardent manipulation to be reported. It is also possible to rupture the bladder by over-distention with an irrigating fluid, particularly when the patient is under anesthesia. It is, however, much more likely to occur when there is pathology in the wall of this viscus. If the accident is recognized at the time of the occurrence, the treatment is immediate suprapubic approach, repair of the laceration, and establish-
ment of suprapubic drainage until the wound is healed. If the rupture is intropertoneal it requires drainage of this cavity as well.

In the case of injury from the obstetrical forceps or pinching by a lithotrite, the bladder does not give way until some days after the accident has occurred. Diagnosis of this condition is sometimes easy and obvious. After surgery, development of an abdominal distention and the failure to pass urine should cause immediate consideration to be given to the possibility of such condition. Passage of a catheter into the bladder is not always the wisest procedure, although it can be used as a diagnostic measure. If, after passing such catheter, no urine comes out, one may place a measured amount of fluid into the bladder and then aspirate it. If less comes out than was put in, the diagnosis is established. If time permits, the use of an intravenous x-ray study will, of course, reveal not only the presence of fluid outside of the bladder, but, in some cases, may give the location of the lesion.

The use of radium or x-ray, for the treatment of carcinoma of the uterus may cause a necrosis of the bladder as late as one to ten years after treatment has been instituted. Archie L. Dean, Jr., in 1933, reported forty-seven cases of bladder fistula following radiation therapy. The exact pathological factor is the production of an obliteratorative endarteritis.

Development of fistula as an obstetrical accident usually occurs about a week after labor, and is due to either pinching of the membrane with the forceps or the pressure of the oncoming head. The treatment of it is prevention. If it is present, diversion of the urine is of primal importance. If it occurs very early post-partum, it is not wise to be in too big a hurry to repair it. The placing of an indwelling catheter and the turning of the patient upon her face for two or three weeks may be all that is necessary to establish the cure. The various techniques for surgical repair do not come within the province of this paper.

In concluding this discussion of bladder injury, we would like to emphasize the necessity of avoiding postoperative over-distention. Too frequently orders are written for "catheterization every eight hours," and the delay causes an over-distention of the musculature with resultant loss of tone. An order calling for catheterization every six hours is more in order. If the patient has not voided spontaneously within thirty-six hours, the placing of the indwelling catheter, thus allowing the bladder to completely empty itself and the musculature to rest, is usually all that is needed. Leaving a catheter in for forty-eight hours will almost always result in the establishment of normal micturition upon removal of the catheter.

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INTERVENTRICULAR SEPTAL DEFECT: 
REPORT OF TWO PROBABLE CASES

VICTOR R. FISHER
Assistant in Clinical Osteopathy

LOCALIZED ventricular septal defect was first described by Roger in 1879 and is often referred to as "the Maladie de Roger." This abnormal communication between the two ventricles is quite common and ranks as the second most frequent congenital anomaly of the heart. The perforation is usually small, measuring one-half centimeter in diameter, and is most often located just beneath the aortic orifice in the membranous or undefended space, so called because normally the septum here consists of two layers of endocardium. Less frequently, the defect lies in the anterior part of the septum and opens into the conus of the right ventricle just below the pulmonary valve. In the majority of instances, septal defects occur in association with other abnormalities such as right-sided position of the aorta or pulmonary stenosis.

Dyspnea and fatigue are the only symptoms of cardiac embarrassment generally produced by this condition. Subacute bacterial endocarditis is a frequent complication, and for this reason very few patients live beyond the age of forty.

The diagnosis is established mainly by the character of the murmur. It is usually loud, harsh, heard best in the third interspace to the left of the sternum, and is uncomplicated by the presence of other murmurs. The characteristic feature of the murmur is its length. It begins with systole and is prolonged into diastole, and it often obscures the second sound almost entirely. A systolic thrill is often present. Roger, in his original description, reported "a very extensive thrill which exactly coincides with the murmur."

Radiologically, interventricular septal defect is usually associated with enlargement of the right ventricle and dilatation of the pulmonary artery; however, there is no characteristic picture.

Evidence of interference with the conduction system occasionally can be demonstrated electrocardiographically.

If it were not for the frequency with which subacute bacterial endocarditis is superimposed on this congenital anomaly, the prognosis would be excellent.

Since there is no characteristic radiological or electrocardiographic picture of interventricular septal defect, the diagnosis can be confirmed only at autopsy. The following two case reports concern living patients: therefore the diagnoses must be suggestive ones and obviously dependent upon the future for confirmation.
Case 1 F.S.

**Historical:** A thirty year old housewife was first seen on November 11, 1941. The chief complaint at that time was extreme fatigue and dyspnea on exertion. This complaint had its onset ten years previously following pregnancy. She had neither improved nor become worse, and had been under constant treatment for rheumatic heart disease.

The family history was non-contributory. Both her mother and father were living and in good health. She had two sisters and one brother living and well.

The past medical history was positive for the usual diseases of childhood without any complications. Her tonsils were removed at the age of nine, and her appendix at nineteen. She had one pregnancy and has one child ten years of age. She had been hospitalized for a period of one week, two years previously, at which time she was treated for digitalis intoxication. Since then she has been taking digitalis intermittently and has been on markedly restricted activities to the point of practically being a cardiac invalid.

Physical examination revealed a well developed, well nourished female, comfortably sitting up. There were no obvious signs of distress. Her weight was 115 pounds, and she was 60.5 inches in height. The temperature was 98.1° F., pulse rate 80, and respirations 20. The blood pressure was 105 systolic and 65 diastolic in both arms, and 115 systolic in both legs.

The pupillary reflexes were normal. Examination of the eye grounds revealed a normal vascular pattern and normal disc contour.

The chest was normal in contour and resonant throughout. The heart was relatively normal in size and position. A systolic thrill was elicited over the third interspace to the left of the lateral sternal line. The heart

![Systolic and Diastolic Graph](image-url)

*Figure 1. Stethogram made with the patient supine and the microphone over the third intercostal space at the left lateral sternal line. Patient I.*
sounds were normal in rhythm and duration. A loud, harsh systolic murmur was elicited with maximum intensity over the third interspace to the left of the sternum and transmitted to the apex. The murmur was heard best in the upright and left lateral positions. (See stethogram, figure 1.)

![Figure 2. Electrocardiogram of patient I. Leads I, II, III and CF5 from above downward.](image)

The abdomen was soft. There was no evidence of hepatic enlargement. The spleen was not palpable and there were no areas of sensitivity or palpable masses present.

Both the superficial and deep tendon reflexes were normal. There was no edema.
Electrocardiographic Examination (See figure 2)

Rhythm: Sinus

Auricular rate: 75 per minute

Ventricular rate: 75 per minute

Conduction time:
  P.R. interval: 0.20 second
  QRS: 0.08 second

P. waves: Upright in leads 1, 2, 3, and CF5

QRS main ventricular deflection:
  $S = 5$ mm. in lead 1
  $R = 6$ mm. in lead 3

R. ST. segments: Isoelectric in all leads

T. waves: Upright in leads 1, 2, and CF5
  Biphasic in lead 3 (− +)

Interpretation: Right axis deviation

X-ray examination of the chest was negative for either pulmonary or cardiac pathology.

This patient has been under observation for the past two years, during which time she has taken no digitalis and has lived a relatively normal existence with only slight modification of activities.

Case 2  F.K.

A twenty year old unmarried female, typist by occupation, was first seen on September 21, 1943. The complaint at that time was fatigue, poor appetite, and loss of weight. Mild fatigue had its onset three months previously. Within the past week it had become more severe. Her appetite had been poor for the past three or four months, and she had lost approximately twenty pounds in the past two years.

The family history revealed the death of her mother at age twenty-six as the result of an automobile accident. Her father was fifty-one years of age and in good health. She had one brother living and well.

The past medical history noted the usual diseases of childhood with no complications. Her tonsils were removed when she was seven years of age. She had a rather severe attack of Vincent's angina at ten. She had been told that she had a leaking heart at birth and that her lips were blue until she was about one and one-half years old. While going to school,
she had always been on restricted activities and was allowed the use of the elevator. She had always been underweight and had been studied several times for tuberculosis but found negative.

Thorough systemic inquiry elicited the complaints of shortness of breath on greater than average exertion, and severe abdominal pain on the first day of the menses.

![Stethogram](image)

*Figure 3. Stethogram made with the patient supine and the microphone over the fourth intercostal space at the left lateral sternal line. Patient II.*

Physical examination revealed a well-developed, rather thin female, comfortably sitting up. There were no obvious signs of distress. Her weight was 106 pounds and she was 65 inches in height. The temperature was 98.4° F., pulse 90 per minute and respirations 20. The blood pressure was 96 systolic and 68 diastolic in both arms, and 110 systolic in both legs. The skin was warm and moist.

The pupillary reflexes were normal. Examination of the eye grounds revealed a normal vascular pattern and normal disc contour.

The chest was long and flat, but completely resonant. The heart was relatively normal in size and position. A systolic thrill was elicited over the fourth interspace to the left of the lateral sternal line. The heart sounds were normal in rhythm, duration, and intensity. A loud, harsh systolic murmur was elicited to the left of the midsternum and transmitted over the entire precordium. The murmur was heard best in the upright and left lateral positions. (See stethogram, figure 3.)

The abdomen was soft. There was no evidence of enlargement of the liver. The spleen was not enlarged, and there were no areas of sensitivity or palpable masses present.

Both the superficial and deep tendon reflexes were normal. There was no edema.
Figure 4. Electrocardiogram of patient II. Leads I, II, III, and CF5 from above downward.
Electrocardiographic Examination (See figure 4.)

Rhythm: Sinus

Auricular rate: 80 per minute

Ventricular rate: 80 per minute

Conduction time:
  P.R. interval: 0.16 second
  QRS: 0.06 second

P. waves: Upright in all leads

QRS main ventricular deflection:
  S = 5 mm. in lead 1
  R = 4 mm. in lead 3
  M.V.D. — slurred in leads 1 and 3

R. ST. segments: Isoelectric in all leads

T. waves: Upright in leads 1, 2, and CF5
          Inverted in lead 3

Interpretation: Right axis deviation

Summary

A brief summary of the pathology, symptoms, and signs of ventricular septal defect is presented.

Two cases suggestive of ventricular septal defect in young females with similar symptoms and physical findings are presented.

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PULMONARY EMBOLISM UNASSOCIATED WITH SURGERY OR OBSTETRICS
AUTOPSY REPORT OF A CASE*

Otterbein Dressler
Professor of Pathology in the College and Special Deputy Coroner,
City of Philadelphia

The disheartening frequency of pulmonary embolism in surgical and obstetrical practice has already been referred to in this Journal. The following case is to show a circumstance such as frequently occurs, but which is diagnosed, without autopsy, as a "cerebral vascular accident" or, simply, "heart failure."

Autopsy No. 1862
Died: 7-4-43, 7:25 p.m.
Autopsy: 7-5-43, 2:00 p.m.
At the City Morgue

Clinical Data
A colored male, said to be 82 years old, was said "to have collapsed in the bathroom" and one would judge, died almost immediately. No other information was obtainable.

External Examination
The body was that of a remarkably well preserved colored male. The right leg was 3.5 cm. shorter than the left. The left leg was greater in diameter than the right, and the left foot was somewhat everted. The lower abdomen was distended, which distention proved to be due to a great accumulation of urine in the urinary bladder. A tumor mass 8 cm. in diameter was found just under the skin in the left infraclavicular fossa. This tumor proved to be a lipoma. A cataract involved the right eye. There were no gross evidences of trauma and no evidences of caustic poisoning.

Internal Examination
The pericardial sac contained approximately 50 cc. of clear amber fluid. The heart measured 15 cm. in greatest diameter, and the thorax, 27 cm., giving a ratio of heart to thorax of 15/27. Right sided dilation of the heart was moderate, and the heart over all measured 15 x 12 x 6 cm. The coronary system showed no obstruction, indeed the coronary vessels were wider and more pliable than average. There were no valvular lesions.

*Case reported through the courtesy of Dr. Herbert M. Goddard, Coroner, and Dr. Benjamin Gouley, Chief Coroner's Physician, City of Philadelphia.
The aorta failed to show any evidences of syphilis, and atheromatous degeneration was remarkably slight.

The pulmonary arteries contained a number of thrombotic fragments tightly wedged and folded upon themselves, completely obstructing both pulmonary arteries. A considerable amount of congestion of both lungs was demonstrated, but much of this congestion was probably post-mortem. The thoracic cavities did not contain any fluid of measurable amount. Adhesions were demonstrated between the visceral and parietal pleurae over the left base, the left lower lobe, and most of the right lung. A small quantity of frothy mucus, somewhat blood tinged, was found in both dependent bronchi.

There were no noteworthy lesions of the digestive tube with the exception of a comparatively large fecolith in the appendix. The latter measured 2 x 1 cm. and was located in the mid-portion of the appendix.

The liver showed some notches, evidencing pressure of the ribs into the liver substance. This liver measured 8 cm. in height. On section there were no evidences of passive hyperemia; indeed, the liver was comparatively firm but not cirrhotic. The gallbladder emptied readily upon pressure and contained no calculi.

There were no noteworthy lesions of the pancreas.

The spleen measured 7 x 7 x 2 cm. and showed some overgrowth of the supporting stroma.

The urinary bladder was greatly distended with 1800 cc. of clear urine. There were no evidences of ammoniacal fermentation and no suggestions of urinary infection. This great dilation of the urinary bladder was due to enlargement of the prostate involving the anterior, middle, and lateral lobes.

The ureters were distended to approximately 3 cm. The kidneys were represented by hydronephrotic sacs measuring respectively, left and right, 12 x 4 x 2 cm. and 13 x 6 x 3 cm. when collapsed. It is to be noted that there were no evidences of infection in the kidneys.

The suprarenal glands presented no noteworthy changes.

The genital organs presented no noteworthy changes.

There were no pathological phenomena observed inside the cranial cavity.

Anatomic Diagnosis

Pulmonary embolism
Benign hyperplasia of the prostate
Bilateral hydronephrosis
Probable phlebitis with thrombosis in the left lower extremity
Cataract, right eye

Cause of Death

Immediate—pulmonary embolism
Contributory—benign hyperplasia of the prostate with bilateral hydronephrosis.
Remarks

In attempting to reconstruct the sequence of clinical events in this case, we would judge that this man had been in bed for a number of hours and responding to the impulse to evacuate the bowels and bladder, he went to the toilet. Perhaps this motion of the body dislodged the thrombi from the lower extremity, but it is more likely that the straining attempts to empty the greatly distended bladder provided the mechanical force. It is not without the realm of possibility that as he sat on the toilet attempting to pass urine he might have manipulated the thigh, dislodging the thrombus.

Summary

A case of sudden unexpected death resulting from pulmonary embolism is reported, this case unassociated with surgical or obstetrical practice.

This embolism occurred while the victim was on the toilet, evidently attempting to empty a greatly distended bladder resulting from prostatism.

In spite of great urinary retention, no urinary sepsis could be demonstrated.

A remarkable physical preservation of an individual at the age of 82 is noted.

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