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**OSGOOD, Robert Bayley. - Lesions of
the tibial tubercle occuring during
adolescence**

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chronic inflammations of the lymphatic vessels are almost never a primary disease but always result from inflammation of the surrounding tissues or parts drained by the affected vessels, some cause outside of the thoracic duct must be found to explain the case at hand. This cause is attributed to the old tubercular focus at the left apex, where a half dozen nodules were found which had undergone caseous and calcareous degeneration, and were surrounded by thick fibrous walls. This fibrous tissue had so developed in the surrounding pulmonary tissue that no semblance of alveoli were to be found. The process had not stopped here, but the two lobes, compressed so that together they were no larger than the two fists, were so tightly bound down to the upper and posterior pleural wall by firm fibrous adhesions that the lung could not be torn out, but had to be cut, this producing a loud grating noise. The thoracic duct winds directly around the left apex as it comes from behind the esophagus at the seventh cervical vertebra, and comes outward to empty into the left subclavian vein. What an enormous process this fibroid degeneration was can be recognized by the sections taken at a dozen different levels where it is seen that the densest fibroid deposit is in the lumen of the duct as well as in the walls themselves, where occasionally, when a few muscular fibers are left, as one section shows very prettily, the fibrous tissue is seen deposited in between these fibers.

The "American Textbook of Pathology," after describing acute lymphangitis as swelling of the intima, proliferation and desquamation of the endothelial cells and an infiltration of the walls, and often of the surrounding tissues, — perilymphangitis, — with round cells, speaks of the coagulation of lymph with a formation of a thrombus as of frequent occurrence; that slight attacks often end in resolution, but that in severe septic cases the thrombus softens, the vessel ruptures, and the neighboring parts become infiltrated with pus. Then it adds: "Occasionally the process ends in fibroid thickening of the coats of the vessel with partial or complete obliteration of its lumen. This is called chronic lymphangitis."

This condition of chronic lymphangitis involved a whole foot and a half of ductus thoracicus in Dr. Conroy's case. The dozen sections show fibrous occlusion of the lumen in them all.

The German writers make mention of the fact that pulmonary tuberculosis begins at some period in life in about 50% of all individuals; in most cases without the knowledge of the individual himself. One is struck on seeing a large number of autopsies by the fact that the visceral pleura is adherent to the parietal pleura in such a large number of the cases, and without any previous history of pleurisy.

At the present day there is no longer doubt that a tubercular process may be brought to a standstill for many years and also even completely healed by the tubercular focus being surrounded by indurated connective tissue, making the spread of the tubercle bacilli more difficult. If the disease has started in the lungs, the extension first follows in the lymph channels, and in this way after a time without exception the peribronchial lymph glands, and frequently the visceral pleura, become involved.

From the latter the costal pleura can become infected. If an eruption takes place of miliary nodules formed by reabsorption, the process is called miliary tubercular lymphangitis." — Ziegler.

The extension of tuberculosis from the primary focus of infection is usually affected through the lymph channel, and in some instances the vessels themselves are involved in transmitting the disease. In tubercular ulceration of the intestines, miliary tubercles are frequently found in the serous coat along the lymphatics, which run to the nearest mesenteric glands. Tubercular lesions of the skin and subcutaneous tissue are sometimes associated with tubercular lymphangitis. The invasion of the thoracic duct by tubercles may lead to a general infection.

It is an interesting fact that all the parts drained by the thoracic duct were filled with fluid, edematous, pitting markedly on pressure. This was so of both legs, abdominal cavity, left thorax and left arm, while the parts drained by the right lymphatic duct were not so affected, the right arm being greatly atrophied. It was not surprising that last spring there should have been acute lymphangitis of the lymphatics of both legs, due to backing up and disturbance of the lymphatic circulation, when lymph thrombi were formed. This acute lymphangitis very closely resembles phlebitis, according to Vidal.

LESIONS OF THE TIBIAL TUBERCLE OCCURRING DURING ADOLESCENCE.

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(1) INTRODUCTION.

Fractures of the tubercle of the tibia have for many years been recognized and have been considered almost as curiosities. The reported cases are nearly all those of fracture and marked separation, and are undoubtedly rare. There are, however, other lesions representing less severe forms of injury to the tubercle. These are interesting because they have apparently been seldom recognized and because of their comparatively frequent occurrence; because of the old difficulty of diagnosis and our present simple and accurate means, and because of their relation to the development of the tubercle.

(2) DEVELOPMENT OF THE TUBERCLE.

The tubercle of the tibia develops ordinarily from the upper epiphysis of the tibia by the ossification of a tongue-like process extending downwards over the anterior surface of the diaphysis. Rarely there is a separate center of ossification for the tubercle which then develops as a separate epiphysis uniting with the upper epiphysis during the latter portion of adolescence.

Henke describes a cartilaginous plate, existing in the newborn and throughout early life, lying in front of the epiphysis and diaphysis of the upper end of the tibia. In a dissection of the knee of the newborn I have found this plate apparently a part of the cartilage of the upper epiphysis. Prof. Thomas Dwight of the Harvard Medical School has allowed me to study his specimens of human fetuses prepared by Dr. E. B. Young after a Ger-



FIG. 1.—Normal knee at five years. Showing shadow of cartilage from which the tubercle develops.



FIG. 2.—Tubercle developing as a separate bone center.



FIG. 3.—Tubercle developing as a tongue-like process from the epiphysis.



FIG. 4.—Complete avulsion of tibial tubercle patella is seen higher than normal on the femoral shaft.



FIG. 5.—Partial separation of tubercle with tearing away of small fragment. Cf. Fig. 6.



FIG. 6.—Normal knee. This is the asymptomatic knee of the case shown in Fig. 5.



FIG. 7. — Separation of a small fragment of the tubercle. Cf. Fig. 8.



FIG. 8. — Normal knee. Symptomless knee of case shown in Fig. 7.



FIG. 9. — Separation of a small fragment of the tubercle. Cf. Fig. 10.



FIG. 10. — Other knee of case shown in Fig. 9, causing slight typical symptoms and representing partial separation of tongue.



FIG. 11. — End result of old lesion of tubercle. Cf. Fig. 12.



FIG. 12. — Normal knee of case showing old lesion in Fig. 11.

man method. By the action of certain chemical solutions the flesh is rendered transparent and the bone centers and cartilaginous epiphyses opaque. In these the upper epiphysis is seen to consist of a superior portion, corresponding to the contour of the future tibial head, and a tongue-like process extending downward anteriorly over the diaphysis.

It seems probable, therefore, that the ossification of the tibial tubercle usually begins about the age of puberty. Ordinarily it represents a downward extension in the cartilage, of the ossifying center for the tibial head. Sometimes the epiphysis at the upper end of the tibia has two separate centers of ossification, one in the head proper and the other in the tongue-like process which later forms the tubercle, the two uniting soon after puberty.

Fig. 1 shows the shadow of the above-mentioned plate; Fig. 2, the tubercle developing as a separate bone center, and 3 as a tongue-like prolongation from the upper epiphysis.

(3) ANATOMY OF THE TUBERCLE DURING ADOLESCENCE.

If in the light of the development, the anatomy of the tubercle of the tibia in early adolescence is studied, it will be seen that the conditions are favorable for just the form of injuries to be described.

To the tip of a tongue-like process of bone, or to a separate bone center, is attached the tendon of one of the most powerful muscle groups in the body. This tongue or bone center is at the age at which the lesions occur separated from the strong shaft of bone by a layer of cartilage, and the first strain of the contraction of the quadriceps transmitted by the patella tendon comes on the tibial tubercle.

(4) REPORT OF DISSECTIONS AND EXPERIMENTS.

Morris and several other anatomists, in describing the insertion of the quadriceps, mention two strong aponeurotic expansions of the tendon which pass down on either side of the patella tendon, are inserted into this and into the two rough oblique lines on the shaft of the tibia, extending from the tubercle obliquely upwards as far as the internal and external lateral ligaments.

To more fully understand the anatomical conditions and the transmission of the forces exerted by the sudden powerful contraction of the quadriceps extensor, dissections of two adult knees have been made.

Dissection 1.—By the ordinary crucial incisions, the skin and the subcutaneous tissues were dissected back and the deep fascia exposed. From each side of the quadriceps, just above its insertion into the patella, were found dense shining tendinous fibers arranged in several connected columns. These passed down on each side of the patella, were inserted slightly into this and the patella tendon, but for the most part were attached firmly to the oblique lines of the tibia above described for about one and one-half inches. These were freed from their attachments to the bone and periosteum. They were found to be only loosely attached to the underlying structures and of considerable thickness and great strength.

Dissection 2.—In a second knee the skin and subcutaneous tissues were dissected back in a similar manner to Dissection 1, and the same dense bands found. The dissection was then carried upwards and the quadriceps muscle isolated. Traction upon this extended the knee, and the strain appeared to be taken first by the patella tendon, almost immediately followed by a tightening of these bands of accessory tendons.

With a chisel, the tibial tubercle was then fractured, leaving the patella tendon still attached to it. The few fibers of the tendon continued below the tubercle, and the slight insertion into the tendon of the above-mentioned lateral expansions were divided; the patella tendon was now isolated well above the deep bursa.

The conditions were now analogous to a complete fracture of the tubercle, and a detachment of the patella tendon from its point of pull.

The knee was flexed, and barely a quarter of an inch separation of the tubercle from its original situation occurred. The tubercle was then replaced and held loosely in position. By traction on the isolated quadriceps it was found that the knee could be practically fully extended without any difficulty, and that about one fourth of an inch displacement of the tubercle occurred. The first pull was transmitted mainly to the patella tendon and tubercle, and when that had yielded barely one fourth of an inch, it was adequately taken by the lateral expansions of the tendon of the quadriceps. The dissection made evident the strength of these expansions and their ability to act as tendons of insertion with a detached patella tendon, and also the fact that the knee could readily be extended with the attachment of the patella tendon gone.

(5) LESIONS OF THE TUBERCLE.

We come now to lesions of the tubercle occurring during adolescence. These consist in a solution of continuity between the tubercle and the tibial shaft. They vary in severity from a complete avulsion of the tubercle to a slight separation of the epiphysis. The symptoms, often mistaken for a fractured patella, a dislocated semilunar cartilage or any of the less acute joint irritations, may represent loss of function varying from complete inability to extend the leg to a slight pain in the region of the tubercle on violent contraction of the quadriceps extensor.

(A) *Complete fracture or avulsion.*—In 1853 De Morgan and A. Shaw both reported cases of fracture of the tibial tubercle due to muscular action, but De Morgan's case was in a so-called scrofulous, poorly developed person, and Shaw's occurred in a boy whose patella was ankylosed.

In 1869 Dr. Paul Vogt reported the first case on record of typical fracture of the tibial tubercle. This case is so typical of the class of subjects and the method of production of this form of lesion that an abstract of it is given.

A thin, muscular boy, sixteen years old, exercising in the gymnasium, slipped from a jumping board and gave a sudden muscular jerk backward to prevent himself from falling. He felt immediate acute pain in the right knee, and could not step or move the leg forward.

The physical examination showed a marked effu-

sion into the joint. The right patella was drawn up higher than the left, and 6 cm. below its lower edge, in which no change could be felt, was a bony knob covered by tense skin, movable and resting 2 cm. from the tibial crest. On movement crepitus could be elicited. By strongly pushing downwards on the patella, this fragment could be made to approach the tibial crest. After the effusion had subsided under appropriate treatment, attempts to completely replace the fragment were still unsuccessful. Firm fibrous union finally occurred, and though slight lateral motion was still possible a good functional result was obtained.

The diagnosis was made of a fracture of the tibial tubercle. The inferior portion of the tubercle was supposed to have been wholly torn off, the upper part still adhering to the tibial epiphysis.

(1) *Etiology.*—There are about twelve cases reported of this injury. With one or two exceptions they have occurred in athletic youths during the adolescence and have been due to the violent contraction of the quadriceps extensor. The instinctive contraction of all those muscle groups tending to restore equilibrium in a threatened backward fall is usually associated. Fig. 4 represents this form of lesion.

This lesion may be produced more rarely by direct violence, the patient usually falling with the knee flexed on a hard surface. Paul Sandler reports such a case in the *Deutsch. Zeitschrift für Chirurgie*, 1893.

(2) *Diagnosis.*—The clinical picture with the marked swelling and effusion which usually occur may well be mistaken for a fractured patella or even a dislocated semilunar cartilage. To-day, of course, the x-ray would at once reveal the true condition. We must suppose in these cases that the lateral expansions of the quadriceps tendon were ruptured.

(3) The conservative treatment of complete immobilization for six to eight weeks has uniformly brought about a return to practically normal function in the reported cases, even though the fragment is not completely restored to its old position. Ogilvie Will, mistaking an avulsion of the tubercle for a broken patella, operated upon a boy, and, discovering the true lesion replaced the tubercle, thrust his drill through the fragment into the tibial shaft and obtained quick union. The drill was removed in three weeks. He recommends operation.

(B) *Separation of a fragment.*—It would seem from the experimental dissections that the first pull in a violent contraction of the quadriceps extensor comes on the fibers of the patella tendon, and is then taken also by the lateral expansions of the tendon of the quadriceps. In the complete avulsions and fractures, as stated above, we must suppose these accessory tendons to be torn from their attachments together with the tubercle and the patella tendon. With these still "in situ" the displacement would be less than is shown by the clinical and x-ray examinations.

It is possible, however, to have a partial separation of the tubercle and the interference with normal function be so slight that the condition is often unrecognized and the diagnosis made of a bursitis or a periostitis, or even a joint fringe (see Figs. 5, 6, 7, 8, 9). The x-ray evidence of this is appar-

ently indisputable and the clinical picture absolutely consistent with the true condition.

(1) *Clinical picture.*—These lesions occur in boys at or shortly after the age of puberty, when the epiphyseal growth is most rapid and a layer of cartilage intervenes between the epiphysis and the tibial shaft. In eight of the ten cases collected the boys were between fourteen and fifteen years of age; one was thirteen and the other sixteen. The boys were all active, athletic and well-developed muscularly. The histories and clinical pictures are very similar.

In the gymnasium, in running, in a football game, or in some athletic sport, the knee is "strained." This so-called strain is usually found on questioning to have been caused by the sudden violent extension of the leg; namely, by the strong contraction of the quadriceps. More rarely there is associated a fall on the flexed knee which would, of course, bring a sudden involuntary strain on the patella tendon, associated with trauma.

At the time of the injury there is felt acute pain in the knee referred to below the patella. There is often slight swelling, either general, or pretty definitely localized over the region of the tubercle. There is distinct tenderness at this point. The ability to use the leg is only slightly diminished, and the acute pain is soon replaced by a feeling of weakness on strong exertion. Sharp pain is present on violent extension or extreme flexion of the leg, and the patient usually consults the surgeon because of this pain, the annoying weakness and the continued localized swelling or tenderness.

The condition presents no complete loss of function, but a severe handicap to the active, athletic life which this class of patients wish to lead.

(2) *Diagnosis.*—In these cases the thing clinically which we must suppose to occur, and which the x-rays confirm, is that a violent contraction or sudden strain of the quadriceps extensor partially ruptures the cartilaginous union of the tongue-like prolongation of the upper epiphysis or the separate ossifying center. A portion of this may be torn away, as shown in Figs. 5, 7, 9, or perhaps the tongue may be simply separated to a variable extent, illustrated by Fig. 10.

Subsequent exertion of any kind, and sometimes the ordinary walking pull of the quadriceps, irritates the injured cartilage and gives rise to discomfort, until advice is sought or bony union at length takes place.

In two of the cases showing this lesion there had been no known wrench or trauma. The symptoms being the same as in the cases presenting recognized, definite trauma. A somewhat exaggerated separation, shown by the x-ray, in the symptomless leg, perhaps explained the susceptibility to the lesion. It must be very definitely borne in mind, however, that the normal adolescent tibial tubercle, when ossification is going on, often appears in the x-ray to be separated from the tibial crest. This is mentioned and illustrated by Dr. Robert Lovett in the *Philadelphia Medical Journal*, Jan. 6, 1900.

The precaution of taking both knees in exactly the same plane, and with the Crooke's tube focused over symmetrical points, must also be observed before the x-ray can be relied upon as final evidence of this injury.

Given, however, a strain of the knee, a more prominent and tender tubercle on the injured side and an x-ray taken in the same plane as the skiagraph of the normal knee, and showing a wider separation of the epiphysis, or an avulsion of a small portion, we may be reasonably sure of the diagnosis.

(3) *Treatment.*—The bursa directly above the tubercle and beneath the patella tendon in a small percentage of cases communicates directly with the joint. There may be enough bursitis set up to bring about a definite synovitis, for which complete immobilization may be necessary. Ordinarily treatment directed toward lessening the pull of the patella tendon and restricting motion is adequate for the relief of the symptoms. A tightly applied crisscross strapping of adhesive plaster extending around about two thirds of the circumference of the leg, and applied from perhaps one inch below the tubercle to one inch above the lower border of the patella, has proved a satisfactory method of accomplishing this end. This is renewed as it becomes loosened, perhaps every ten days, for about a month, and a flannel bandage worn for a few weeks after this.

(4) *Prognosis.*—The prognosis with treatment has been uniformly good as to relief of pain and restoration of function. A case in which the end result is shown in Fig. 11 had been treated unintelligently, because of failure to make the diagnosis, and the history has been one of considerable pain and annoyance, coupled with restricted exercise for a period of years.

(6) CONCLUSIONS.

The adolescent tibial tubercle, from its situation and mode of development, is susceptible to injuries, especially in athletic subjects. These lesions are usually caused by a violent contraction of the quadriceps extensor.

Fracture and complete avulsions of the tubercle are rare, cause loss of function, and are easily diagnosed, usually clinically and always by means of the x-ray.

Avulsions of a small portion and partial separation of the tubercle are more common. They do not cause complete loss of function, but without treatment, long continued serious annoyance. The diagnosis should be made by a combination of the clinical and x-ray pictures, and before the latter are accepted as evidence both knees should be skiagraphed and accurate technique observed.

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THE SIDE CHAIN THEORY.¹

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RECENT studies of immunity are so interesting and so full of promise of helpfulness, and yet withal so hard to get hold of, that we who are far from being masters in pathology find plenty of reason for trying to make them clear to each other.

Organotherapy was at least easy to understand. Through the work of Horsley, Murray and others, the homely, old counsel, "Eat a part to strengthen a part" becomes, to a limited extent, a therapeutic principle. In myxedema the blood lacks something which the thyroid gland fails to furnish. Sheep's thyroids supply the lack. It is blood poverty, rather than blood infection; but whatever it is, Murray applies his theory, and for a time the patient ceases to be myxedematous. By a reversal of the usual sequence, a pathological condition is made clear by therapeutic means.

There was an appearance of simplicity, also, in the theory of antitoxin, as applied to tetanus and diphtheria. Behring had isolated an antidote which neutralized the diphtheritic poison. If our theory about it has grown more complex, certainly time has not dimmed the glory of the fact.

Tetanus and diphtheria are local first, and toxic in a general sense afterwards. Their bacilli are known and their poisons can be isolated. When, however, effort was directed toward finding antitoxins for the exanthemata, whose bacilli are as yet unknown, and for tuberculosis, whose toxin refuses to react according to predetermined rules, pathologists encountered difficulties which we, in our ignorant expectation, failed to realize. The past five years have thrown to us much that is obscure and almost discouraging. Editorial contributors have written with easy familiarity about amboceptors and alexins and haptophoric groups. Ideas which are really illuminating have been buried in Greek derivatives and in clumsiness of statement. Little by little, however, theories concerning immunity have precipitated and clarified, so that we can see through a part of them and find suggestions which bewilder, not so much because they are intricate as because they are dazzling with promise of future insight and resource.

In studying the numerous diseases which are manifestly infectious and presumably bacterial, but in which there are, as yet, no recognized bacterial causes, we may be forced to rely upon unproven theory for a long time to come. Smallpox and syphilis are conspicuous examples of this class of diseases. As Lister himself has pointed out, the limit of possible improvement in the power of the microscope may be nearly or even fully reached already. If then, the bacterium of syphilis should chance to be smaller than the bacillus of influenza to the degree in which this bacillus exceeds in smallness the bacillus anthracis, it is improbable that the hypotheated bacterium of syphilis will ever be seen. Moreover, the virus of syphilis, familiar as it is clinically, cannot be made the subject of study by animal experimentation because

¹ Read at the Lister Club, Dec. 18, 1909.