

## ON MYOSITIS OSSIFICANS TRAUMATICA.

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BONE may be formed in muscle or tendon under several distinct conditions. In the first place, there may be a process of ossification attacking one muscle after another, especially those of the trunk posteriorly, until the patient is in a truly pitiable state. The cause is totally unknown, but our profession has named the disease *myositis ossificans progressiva*, while the showman dubs the victim "the ossified man." I believe progressive ossifying myositis less uncommon than is usually supposed, as in the course of the present inquiry I have run across the tracks of several cases.

Another well-known condition in which bone forms in muscle or tendon is the result of slight traumata frequently repeated during a more or less extended period of time. Well-known examples of this condition are "rider's bone" in the origin of the adductors of the thigh; "cavalryman's bone," an osseous plate where the sabre hits the outer side of the thigh; "drill-bone" in the deltoid; "fencer's bone" in the *brachialis anticus*, due to repeated overextension of that muscle incident to the peculiar mode of fencing adopted by the German students in their duels.

Lastly, there is the so-called *myositis ossificans traumatica*, where a mass of bone forms in a muscle after a single injury. It is with this condition that the present paper has to do, and the subject may be introduced most easily by the recitation of an individual case.

G. O., aged forty-one years, seen by me September 19, 1902. Two weeks ago, while boxing in gymnasium, received a severe bruise on the right forearm and arm. Swelling and ecchymosis were marked, but soon disappeared under domestic remedies.

During the past two or three days has noticed a tumor in upper arm and pain on extending the elbow. On examination, one finds at the junction of the middle and lower thirds on the inner side of the right arm a tumor which passes down towards the elbow. The tumor is elongated, hard, size of a large thumb, movable from side to side, but not up and down; fairly tender. It is close to but not apparently intimately attached to the humerus, lies beneath the biceps, and is crossed by the brachial artery. There is no pulsation in the tumor, no radiating pain. Flexion of the elbow is normal; extension is slow and painful. There is no change in the sensibility, etc., of the hand. There is no elevation of temperature or acceleration of the pulse.

September 26, 1902. The tumor has increased slightly in size and disability is more marked. Chloroform; longitudinal incision over the tumor. Retracted biceps to outer side and the brachial vessels and nerves to inner, exposing a grizzily, hard, non-vascular tumor lying in the brachialis anticus muscle. The tumor was separated from its muscular bed by sharp and blunt dissection. At its upper end it was attached to the humerus, but the attachment was easily separated by a blunt periosteal elevator, leaving an area of humerus one inch square denuded of periosteum, but *not* rough. The corresponding surface of the tumor was rough. Along with the tumor a considerable amount of the brachialis anticus muscle was excised. The wound was closed with catgut and healed *per primam*. There has been no recurrence to date (March, 1903) and there is no disability.

The tumor is hard, measures two inches in length by five-eighths, by three-quarters of an inch. On longitudinal section it presents the gross appearance of a medullated bone with a narrow, red marrow cavity. The bone is not very hard, can be cut with a knife, but yet contains much gritty bone salts.

The following pathological report was made by Dr. Frank Hall, Professor of Pathology, Kansas City Medical College:

"For convenience of description we may divide the fusiform tumor into a proximal, middle, and distal part. The proximal portion forms a blunt cone, the middle a cylinder, and the distal a blunt cone. Immediately on removal, the tissue was fixed in a 4 per cent. solution of formaldehyde, decalcified in a 5 per cent. aqueous solution of nitric acid, rehardened in alcohol, embedded in celloidin, and cut into sections five micromillimetres thick.

Staining was accomplished with hæmatoxylin in combination with eosin or picrofuchsin. Instructive results were also obtained with methylene-blue and eosin. The cone-shaped proximal and distal portions of the tumor were sectioned parallel to the axis, yielding triangular sections; the middle portion was cut transversely, giving rectangular sections, one side presenting the muscular envelope of the tumor mass, the opposite side the ragged surface of the small central medullary canal. The proximal sections present for examination bundles of longitudinally cut voluntary muscles, intermuscular connective tissue, blood-vessels, and a small amount of fat. The muscle fibres are wavy, variable in diameter, and present very distinct longitudinal fibrillation with but faint transverse striations. The fibres generally react normally to eosin, but here and there one takes on a deep-red stain, either throughout its length or only in segments. These darker fibres or segments of fibres are seen, with the high power, to have lost both longitudinal and transverse striations and to be converted into homogeneous or finely granular masses. The sarcolemma of these affected fibres is more richly nucleated than normal, the nuclei being large, round, and sharply projecting. In a few instances a fibre or a portion of a fibre is represented by a thin granular mass enclosed in a shrunken sarcolemma.

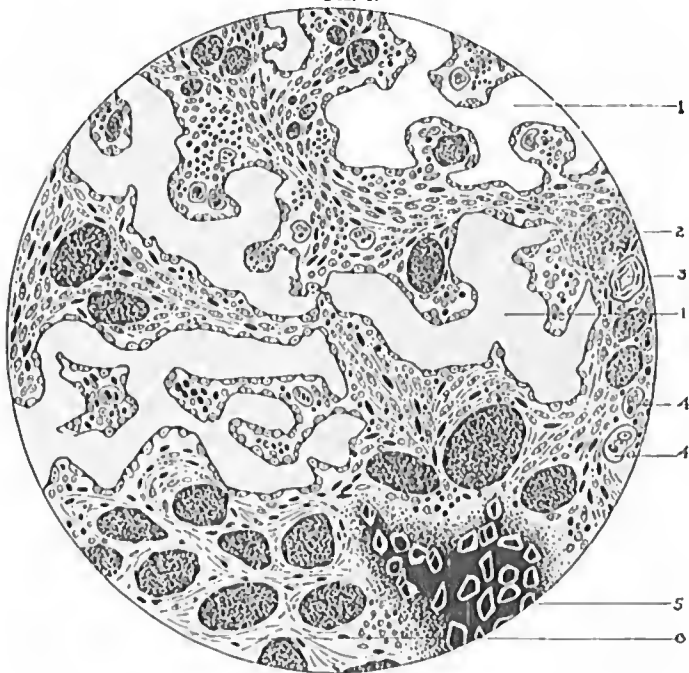
"The intermuscular connective tissue, composing the endomysium and perimysium, presents changes varying in quantity in different regions of the section. The perimysium is irregularly increased throughout, but more especially towards the base of the triangular sections, i.e., towards the centre of the tumor. Changes in this connective tissue are recognizable by a loss of distinct fibrillation and by a failure to react normally to eosin, the color presented being a dark purple. The texture is in part massive, coarsely granular, in part thinly reticulated, the meshes occupied by a fine granular precipitate. The larger masses of connective tissue occur around the blood-vessels and increase in size, progressively, as the base of the section is approached. The nuclei are reduced in number, are either round or dash-shaped, and are darkly stained. At the base of the section the connective tissue suddenly broadens out like a fan, engulfing the muscle fibres and destroying most of them. This region presents a dense mass of tightly compact spindle cells with small linear nuclei. At the centre of the base of the section the density is broken by infil-

trating red blood-cells, large epithelial cells, and a few giant cells. The cells are the precursors of the ossified areas present in the centre of the tumor. The endomysium throughout the section is reduced to a thinly reticulated mass of fine fibrils, forming spaces filled with shadows of red blood-corpuscles and fine granular *débris*. The nuclei are free and lie scattered about in the reticulum. The blood-vessels throughout the apical region of the section are normal in number, engorged with corpuscles, and surrounded by an increased mass of connective tissue. Many of the vessels are apparently subjected to increased pressure, as is shown by their distorted lumina. The fatty mass at the apex of the section presents nothing abnormal, save that its connective tissue is of the same character as that found elsewhere in the section.

"The sections cut from the middle portion of the tumor present the processes exemplified by this material in full blossom. Externally, masses of muscle fibres in cross-section present for inspection. Here we find many dark, red-stained fibres interspersed with normal ones, as noted in the proximal sections. Approaching the centre of the section, the intermuscular connective tissue becomes progressively broadened and thickened with more and more abundant linear nuclei and fewer and fewer blood-vessels. No possible line of demarcation can be detected between the muscular envelope and the osseous centre. Spicules of bone and islands of cartilage arise amidst the masses of intermuscular connective tissue. In many places connective tissue is transformed directly into bone; in other areas the connective-tissue cells seem to surround themselves with a capsule and gradually form about themselves the characteristic homogeneous, blue-staining cartilage matrix. As we approach the centre of the tumor the bony trabeculae developing about and between the muscular fibres push them farther apart, destroying some of them, enclosing others in a tight embrace. The enclosed fibres of muscle vary much in diameter. Some are much larger than normal; others are reduced to little more than pink dots. In some of the fibres one finds, under the high power, several nuclei; in others the centre is vacuolated or reduced to amorphous granules. In many instances the sarcolemma is penetrated by red blood-cells, thus forming a sheath about the sarcons substance. In a few instances the red cells even penetrate into the centres of the fibres.

Strangely enough, a few muscle fibres in a fair state of preservation persist in the very centre of the tumor. On close inspection the new formed bone is seen to be fairly perfectly formed. Each trabecula is clothed in a thick tunie of cubical osteoblasts which come to lie enclosed in lacunae as the process of ossification advances. The islands of cartilage begin to ossify at their periphery.

FIG. 1.



1, Bone trabecula; 2, cross-section of voluntary muscle fibre; 3, cross-section of blood-vessel; 4, multinuclear giant cell; 5, area of cartilage; 6, intermuscular connective tissue. (Drawn by Dr. Frank Hall.)

The forming bone reacts to eosin; thus the bony trabeculae and borders of the cartilage areas are of varying shades of pink. Marrow spaces are abundant and are occupied by a perfect chaos of spindle cells, red blood-cells, muscle fibres, and multinucleated giant cells. Plasma cells are present, but not abundant. The

blood-vessels of the marrow are remarkably few and imperfectly formed. Erythrocytes evenly infiltrate every available space in the marrow. In the centre of the growth are several blood cysts of varying sizes. Some contain well-preserved erythrocytes; others are occupied by a reticulated mass of fine fibrils and amorphous granules.

"The distal portion of the tumor resembles the proximal in every respect. The intermuscular tissues are somewhat more abundant and grade to the normal more gradually. Certain deeply-pigmented cells are scattered in the stroma. These are doubtless wandering cells which have taken up coarse-brown granules of blood pigment."

A number of explanations have been forthcoming as to the origin of intramuscular masses of bone after trauma, and each of the explanations has been subjected to keen criticism.

1. One of the earliest theories expounded was that, as a result of the injury, blood was effused, and this blood became transformed into bone. This theory might have passed muster in the days when it was believed that tissues were regenerated by the direct metamorphosis of blood-corpuscles into connective tissue.

2. The second theory demanding attention is one of great importance and is undoubtedly correct in many cases. It accenses the periosteum of being the "*fons et origo mali*." Osteomata may arise from the periosteum in several ways:

(a) A severe blow is inflicted. The muscle affected is crushed into a pulp. There is injury to a limited and adjacent area of periosteum. The cells of the injured periosteum proliferate, escape into the pulpy area of muscle, and there develop. A mass of bone is formed which may have only a loose connection with the periosteum or may become entirely detached from it.—(F. Berndt.)

(b) A muscle is in action, receives a blow; some of its fibres tear themselves loose from their bony origin and, retracting into the mass of muscle still connected with the bone, carry with them particles of periosteum. These particles of periosteum grow in their new environments, are true bone grafts,

and can form intramuscular osteomata, unconnected with, though originating from, the periosteum.—(Boppe, Demmler, quoted by C. Lyot, *Traité de Chirurgie*. Le Dentu et Delbet, iv, 776.)

Berthier, to prove this theory, detached in rabbits with a knife little flaps of periosteum, and by electrical stimulation of the muscles he succeeded in having these flaps pulled away from the bones, and in time found that where they were there developed little nodes, first of cartilage, then of bone. Delorme was never able to detach periosteum from bone by any force applied to the adductors of the thigh in the cadaver.

(c) As a result of one trauma, a regular flap of periosteum is detached from the bone in whole or in part, and being drawn into the belly of a muscle develops there, forming an osteoma. It is said that a bone cyst may be formed in the above manner.

Dr. Schulz writes (*Beiträge zur klinischen Chirurgie*, Band xxxiii, 541): One must assume that a flap of periosteum was torn entirely free from the femur (he is speaking of a definite case), that this became separated from the bone by blood and fragments of contused and lacerated tissue. The separated flap of periosteum reacts normally to the stimulus of injury by proliferation and ossification; thus a plate of bone is formed separated from the femur by the blood and detritus referred to. But the wounded periosteum surrounding the bone left bare by the detachment of the periosteal flap also reacts to the injury and forms bone, and this new bone meets and fuses with the bone formed in the aforesaid flap; thus a complete bony wall is formed around the blood and detritus and the cyst formation is complete. This notion of Schulz's by no means explains the occurrence of cysts unconnected with the bone; such might possibly arise from the separated fragment of periosteum becoming rolled up in the shape of a capsule around a blood-clot or collection of detritus. If this rolling up occurred and the periosteal cells proliferated and ossified, then, presumably, a blood cyst might be formed.

3. A third theory, that of Cahen, involves the adoption of

the famous Cohnheim theory of the origin of tumors. Cahen considers the osteoma primarily muscular and, when connected with a bone, this connection entirely secondary. He assumes that there have been present in the muscle aberrant masses of embryonic material originally provided for the development of the normal bone, but unused; they have lain in the muscle until stimulated to growth by the trauma. Undoubtedly fetal remnants of various kinds are scattered in various parts of the body—e.g., remnants of the branchial clefts in the neck and of the primitive suprarenal body in the kidney—and as undoubtedly, when subjected to the proper stimulus, these develop into more or less complicated epithelial tumors and cysts in the neck and into hypernephromata in the kidney; so that we are compelled to admit the entire possibility of Cahen's assumption. The probability of the assumption is another matter, and, as there are other and simpler explanations of the condition, one need only bear in mind that such an origin is within the range of possibility, but is so very improbable that it need not be considered with much seriousness.

4. Ziegler assumes that in patients the subjects of myositis ossificans, whether traumatic or progressive, there is a congenital diathesis of the connective tissue of the muscles, fascia, tendons, ligaments, etc., in that they become endowed with powers normally belonging to the periosteum alone. This theory is closely related to the Reichert notion of the connective tissues. Reichert considers that all those tissues which are composed of cells lying in an intermediary or ground substance (bone, cartilage, connective tissue, etc.) are morphological equivalents, each capable, under suitable conditions, of replacing the others. As Pierre Delbet says, "The development of osteomata separate from the skeleton is a powerful argument in favor of Reichert's theory." In the case of progressive myositis ossificans the assumption of Ziegler or the theory of Reichert must be accepted either *in toto* or in some modified form; here there can be no question of periosteal origin; the condition seems to be one of proliferation and metamorphosis of the intramuscular connective tissue. When the so-called



myositis ossificans is limited to one muscle and is the result of a single trauma, there can be little or no doubt that the ossification may proceed from the injured—i.e., the stimulated—periosteum; but that it does so in all cases is hard to believe. Observers have differed in their opinions as to whether the process under consideration is a tumor or an inflammation. Grawitz and Salmon, under Bergmann's auspices (quoted by Rothschild), investigated this matter and, basing their opinion on clinical and microscopical evidence, pronounced the disease inflammatory. Clinically, they found that the temperature was frequently elevated in the early stages, and that the acuteness, the amount of swelling, and the tenderness of the affected muscles all indicated inflammation, while microscopically there was early cloudiness, later degeneration of the muscular fibres; small-cell infiltration of the connective tissues around the altered parenchyma; the presence and enlargement of blood-vessels in the neighborhood. Virchow and most of the older writers think the disease belongs to the border-land between inflammation and tumor, while later pathologists, as Ziegler, Birch-Hirschfeld, and others, lean towards the tumor hypothesis.

It will be noticed that in my case ossification is as far advanced in the distal as in the proximal portions, that around and throughout the tumor there is great proliferation of the intramuscular connective tissue, that ossification is both of the fibrous and cartilaginous type, and that muscle fibres in every stage of degeneration are scattered here, there, and everywhere, lying in the connective tissue, in among the islands of cartilage, and hugged by the trabeculae of bone. There is no microscopical evidence of any inflammatory changes. If this case is one of purely periosteal origin, then the scattering of the periosteal cells or grafts must have been through a territory extraordinary in length and in latitude wonderfully limited. Its origin from a separated periosteal flap is simply inconceivable in view of its relations to the innumerable discreet and degenerating muscular fibres. From careful examination of

even this one case, one is forced to admit the possibility and probability of the bone tumor being the result of proliferation and metamorphosis of the intramuscular connective tissue.

Rothschild's first case supports this view. The tumor developed in six weeks in the brachialis anticus and required removal from the humerus by the chisel. The surface of the humerus at the point where the tumor had been attached was so rough that it gave the impression that a portion of the superficial layers of the bone had been removed with the tumor. Really this roughness was due to a deposit on the bone, which, when removed with the chisel, showed intact periosteum under.

The following cases, most of which were kindly communicated to me by the surgeons in charge, seem to substantiate the muscular origin of the tumors under consideration:

RIXFORD, E. (San Francisco). H. H. C., physician, aged sixty-five years, operated April 15, 1902, for pyloric obstruction. Median incision beginning at the xiphoid was made, and the sheaths of both rectus muscles opened. The operation on the pylorus had to be abandoned, and a simple posterior gastro-enterostomy was done with a Murphy button. Abdominal wall closed in layers with catgut. Recovery rapid. On the seventh day the wound appeared to have healed by primary union. On the tenth day a few cubic centimetres of pus were found at the upper end of the incision. The small cavity was packed with lint saturated in turpentine and oil and rapidly closed. The patient rapidly gained in flesh and strength, and had no discomfort until August, when he had a sharp pain in the cicatrix when he made certain movements. He discovered a small hard mass in the left rectus. In November the bone was about five centimetres long and one centimetre wide. It was *not* attached to the xiphoid, but reached very near it, and was in the edge of the muscle.

February 11, 1903. The bone tumor now measures three inches in length and three-quarters of an inch in width and is separated from the xiphoid by nearly one-half an inch. It causes no discomfort except when the patient bends forward, and then the sharp ends of the bone prick.

MACDONALD, W. G. (Albany, N. Y.). Manufacturer, aged fifty years, who some twenty years previously had received an injury to his chest as the result of an explosion. There was considerable destruction of the skin, and subsequently numerous areas of deposit of bone in the pectoralis major. My best recollection is that there were several areas extirpated, and that the disease first made its appearance distinctly some six or eight years after the primary injury.

MARKS, S. (Milwaukee, Wis.). On the eve of battle I was consulted by a soldier for not only bowel trouble, but for what he called a hard lump located about the middle of the left sartorius muscle. He informed me that it was the result of a blow received some five or six years previously, which made him lame for some time. He said, however, that he was entirely well at the time of enlistment. I regarded it as bony matter. If my memory serves me, he was wounded the next day but one after my examination and died soon after. I procured the specimen, which was about one-eighth of an inch thick and slightly oval and about one inch in length, but in the hurry of movements I lost not only that but many other valuable specimens.

GASTON, J. McFADDEN (Atlanta, Ga.). W. H. E., aged sixty years; old double hydrocele. Injection of Lugol's solution. He presented symptoms of inflammation altogether disproportionate to the treatment given. By incision there was removed pus, disintegrated tissues, and then an osseous formation; recovery. There was absolutely no mistaking the bony mass, which was about the size of a walnut. The existence of this was traceable to an injury to the testicles and the muscles years before.

ELLIOT, J. W. (Boston, Mass.), through the courtesy of Dr. H. B. Howard. E. H., aged thirty-six years, admitted to the Massachusetts General Hospital May 20, 1902. In February, 1902, while working, a box weighing 400 pounds fell on his right leg; skin on the outside of the thigh was scratched and the leg rapidly became swollen. Pained him considerably, and he stopped work for a week on account of stiffness. Then he returned to work for four weeks; he found then it was very painful to go up and down stairs, so he had to give up work, and has not worked since. Pain is just above the joint and feels as if a knife were run into it. Swelling of the leg was reduced with poultices, but of late is becoming hard and appears to be growing larger down towards the joint. On May 31 an incision was made just outside of the vastus externus down onto the tumor. This consisted of a mass of soft spongy bone laid on over the femur and was chiselled off, leaving the shaft and periosteum apparently intact. No sarcoma was found by the microscope. Result: relieved.

F. MUNRO (Middlesborough, Eng., *Lancet*, Vol. i, 1891, p. 427). T. A., aged twenty-four years. May 15, 1890. Playing at football on Easter Wednesday, received a blow from another player's knee in front of right thigh. One week afterwards noticed hard swelling one and a half inches above the outer side of the knee. On examination five weeks after injury "there was found what seemed to be a lump of bone lying loose in the muscles of the outer side of the thigh. It was about eight inches long, narrow, and projecting at its lower end and approaching the surface, but broadening out as it passed up the thigh and lying more in the muscles. It was slightly movable except at its upper end."

June 1. *Operation*.—The mass lay in the substance of the vastus externus, being separated from the femur by a sheet of fibres. The mass was a slightly curved plate about eight inches long, arising from the

origin of the vastus and the linea aspera. It was fully a quarter of an inch thick at its origin, thinning as it passed outward and downward. Professor Greenfield, of Edinburgh, examined the specimen and pronounced it typical myositis ossificans, differing from Orlow's case, which he cites, in not being so vascular and not containing cartilage. Orlow's case (*Virchow's Annual*, 1889) was one of medullated, dark-red bone, without any distinct cortical substance, lying in the upper end of adductor longus muscle, and seen five months after injury was sustained. Orlow believed both periosteum and intermuscular connective tissue took part in the formation of the bone.

VULRIUS (Heidelberg, *Verhandlungen der Deutschen Gesellschaft für Chirurgie*, 1902). J. Z., aged twenty-one years, male, fell on an iron bar, hitting the left thigh. Pain; worked for three weeks. Condition got much worse almost in one night. Could not bend the knee; thigh tender and swollen. On examination, four weeks after injury, there was found distinct swelling of the flexor aspect of the thigh, midway between "spina" and patella. Skin unaltered; tumor long, firm; its centre of bony hardness; not tender; movable on the femur with slight crepitation. The knee can be fully extended both actively and passively, but power is decreased. Flexion is possible to 150 degrees, but then firm obstruction is encountered.

*Operation.*—Incision at the outer edge of the tumor, which was found surrounded by firm, tendon-like connective tissue. In several places indurations penetrated farther into the muscle, and in the centre of these indurations there were bony, hard bodies. Blunt dissection was impossible because of close union with the muscle. The tumor was a cyst surrounded by a complete shell of bone varying in thickness. The cyst was removed in two pieces, as also the neighboring indurations. Neither the femur nor its periosteum was exposed or injured. The tumor on its femoral side was covered by a large layer of degenerated muscle. The cyst was twelve centimetres long, three to four centimetres high, and two to two and a half centimetres wide. The circumference was ten to eleven centimetres. At places the bone was translucent; at others it was two millimetres thick; its cavity was lined with uniform, glistening, bluish membrane which sent septa from one part of the walls to another. The contents of the cyst were extravasated blood.

BERNAYS (St. Louis). Miner, aged forty-five years, from Colorado, had received numerous bumps from an ore-box or basket hitting him just above the knee of the right side. There was a tumor as large as half a small cantaloupe in the quadriceps, which felt hard in spots, of indefinite origin as to time, and slow growth. Extirpation showed an osteoma in the vastus internus extending into the externus, which contained cyst-like cavities filled with mucoid jelly. This was clearly a muscular osteoma and had no connection with the bone or periosteum, unless the attachment of the muscles to the patella are considered, and the tumor was fully four inches above the patella. Extirpation; primary union; no loss of function.

While this case of Bernays's seems to have followed repeated traumata, yet it is so distinctly an example of traumatic myositis without periosteal involvement that it is included here.

Schüler, Heinrich (*Beiträge zur klinischen Chirurgie*, Band xxxiii, 556), in his excellent "arbeit" based on von Brann's material, admits fully the existence of myositis ossificans traumatica, although his paper is concerned with the very similar condition known as traumatic exostoses. He writes, "Such traumatic bone tumors appear to be very rare, much rarer than traumatic bony neoplasms in the muscles, and we have failed to find any such case in literature since Housell's publication (from the same clinic)."

In all the cases reported by Schüler there was a single trauma; in no case was there evidence of a hematoma. The tumors only became noticeable after weeks. The immediate swelling was always slight. In one case the arrangement of tendon tissue on the fragment removed showed that the fragment must have been the point of insertion of the tendon, and that at the moment of injury the tendon pulled off a portion of periosteum with fragments of bone attached. In all the cases periosteum covered the tumors and was firmly united to them, though here and there it showed pathological thickenings. *The musculature was never in any structural relation with the tumors.* The muscle lay on the surface and could be separated by blunt dissection.

It will be seen that there is a very sharp distinction existing between the cases reported by Schüler under the title "traumatic exostoses" and such cases as that reported by me. Undoubtedly many of the cases classed as "myositis ossificans" are truly exostoses, and one might well consider all cases which are of purely periosteal origin to be such, but the difficulty or impossibility of clinically separating the tumors of one origin from those of the other makes it convenient to class them together, and then, to avoid the introduction of theories into nomenclature, we might label such cases "traumatic osteomata" connected or unconnected with the skeleton, as the case may be.

Sometimes, instead of one muscle being the seat of an

osteoma, one whole group of muscles is affected. Bernays (St. Louis) sent me the following report of a boy, aged ten years and of excellent family history:

"Tumor of most peculiar shape. The entire flexor group of muscles arising from the internal condyle of the humerus seemed to be enlarged, swollen, and hardened. Palpation detected hard, spleen-like pieces of bone in the tumor mass. These were only found in the muscular bellies of the flexors. I thought it to be a malignant tumor and advised extirpation, probably to be followed by an amputation. I removed the mass, leaving a sadly mutilated forearm. . . . Primary union. Microscopical examination (and in fact macroscopically I thought the tumor non-malignant) proved it to be a lipoma intramuscularis angiomatodes ossificans. There were irregular, branched, and sponge-like osteomata in four of the muscle bellies. Function now, three or four years after operation, is remarkable, although only the supinator longus was left. The small muscles of the hand have developed immensely. . . ."

In progressive myositis ossificans the process affects fasciae and tendons as well as muscles. Rothschild has only seen one case where, as a result of trauma, there was isolated ossification of tendon, and he has found no reports of such cases, although, as he points out, ossification of tendon is the same in principle as that of muscle, where the process takes place in the intramuscular fibrous tissue.

Rothschild's case. P. K., aged forty-five years. December 20, 1899, heavy coal-wagon went over his left foot. In hospital ten weeks. At the end of this time there was severe pain running from the tendo Achillis round both malleoli to the dorsum of the foot. The patient was unable to walk.

March 3, 1900. Temperature and pulse normal; left leg from the middle of the foot to above the malleoli oedematous; contour of ankle lost; motion in talocrural and talocalcaneonavicular joints normal. Left tendo Achillis was neither visible nor palpable in any position, but in its place is a broad, bony, hard mass springing from the calcaneum, corresponding to the tendo Achillis, reaching to three finger-breadths above the tuberosity of the os calcis and apparently losing itself in the flexor muscles. The right and left margins of the growth are well defined. Oedema rapidly increases on walking. Skiagram shows a spur of bone corresponding to the tendo Achillis.

12th. Operation by Professor Rehn. Most of the tendon has been replaced by an immobile mass of bone lying in tendon tissue. The tumor was separated from the os calcis by a chisel, from remnants of tendon by sharp dissection; recovery.



FIG. 2.—Skiagram of Dr. J. M. T. Finney's case of osteoma in tendo Achillis

Microscopical examination shows connective tissue becoming metamorphosed into cartilage. The long spindle cells become gradually thicker and rounder, surround themselves with a capsule, and inclose a vesicular nucleus until they become true cartilage cells. The cartilage may be seen changing into bone. The cells first lose their capsule, become smaller and thinner, and the intercellular substance becomes denser and opaque.

PINNEY, J. M. T. (Baltimore), has reported to me a case very similar to the above, although the history of an individual injury is not so definite. "The patient was a minister, about fifty years old, who had noticed, following the use of a new, rather tight shoe, a tenderness along the right tendo Achillis. This continued to bother him for some months, until finally he consulted me as to the cause of his trouble. I found a thickened tendo Achillis with external evidence of injury from the top of the shoe in the nature of callus formation, and on examining the tendo Achillis found a hard substance that felt very much like bone. It was about one and one-half inches long by one-half inch in thickness. I had an X-ray taken of both feet, and this showed that the hard substance I felt was true bone, while on the opposite side there was no evidence of bone formation whatever. The patient assured me that the two tendons were alike before the injury spoken of, and that he had noticed himself the formation of this bone in the tendon. I have not seen him for about eight months, but at the end of that time the bone formation had progressed perceptibly since my first examination. I am not quite sure whether the bone was confined entirely to the tendon or whether or not it had involved to a certain extent the lower portion of the muscle, since I did not operate."

*Statistics.*—For the sake of convenience, I will place all the cases of traumatic osteomata, whether connected or unconnected with the skeleton, in one group, indicating by a double asterisk those considered by the authors themselves to be traumatic exostoses. Although I have verified most of the references given in Rothschild's and Vulpius's lists, yet it will be convenient to omit the numerous individual references. The cases marked by a single asterisk have been reported to me by personal communication. I desire to take this opportunity of expressing my sincere thanks to the numerous colleagues, both in America and Europe, who have, at the expense of time and trouble, most kindly and courteously aided me in the preparation of this paper. Especially are my thanks due to my friend, Dr. Frank Hall, for the beautiful preparations and drawing he has made from my specimens.



Dr. Otto Rothschild. "Ueber Myositis ossificans traumatica."

(*Beiträge zur klinischen Chirurgie*, 1900, Band xxviii, 1.)

1816. Otto,	Diaphragm.....	1
1851. Schuh,	Vastus ext.....	1
1856. Rokitsansky,	Biceps.....	1
1863. v. Pitka,	{ a. Brach. int.....	1
	{ b. Both brach. int.....	2
Barth,	Rect. fem.....	1
Sangalli,	Digastric.....	1
1873. Podratzky,	Brach. ant.....	1
Billroth,	Biceps.....	1
Elstein,	Ileopsoas.....	1
Busch,	Psoas.....	1
Konetschke,	Gluteus max.....	1
Weinlechner,	Ant. of thigh.....	1
Meinhold,	Quadriceps.....	1
Rasmussen,	Brach. ant.....	2
	{ Vastus ext.....	1
Cohen,	{ Quadriceps.....	2
	{ Brach. ant.....	1
Salman,	Ileopsoas [Trauma?].	1
Ruthke,	Ant. of thigh.....	1
	{ Shoulder.....	1
Brenig,	{ Vastus int.....	1
	{ Vastus med. and ext.....	1
	{ Brach. ant.....	1
Rothschild,	{ Tendo Achillis.....	1

Dr. Oscar Vulpius (Heidelberg). "Zur Kenntniss der intra-musculären Knocheneubildung nach Trauma."

(*Verhandlungen der Deutschen Gesellschaft für Chirurgie*, 1902, Vol. ii, p. 127.)

Grunbaum.....	2
Elhogan.....	3
Schultz.....	7
Sudeck.....	1
Regnier, Brach. ant.....	2
Zhoher and Oklot.....	2
Zimmerman.....	1

Dr. Rammstedt (Halle). (*Archiv für klinischen Chirurgie*, Vol. lvi, p. 153.)

Martin, Vastus int.....	1
Rammstedt, Vastus int.....	2

Dr. Berndt. (*Archiv für klinischen Chirurgie*, Vol. lxx, p. 2.)

In muscles outer side thigh.....	3
(Two were in same patient from separate kicks.)	

Dr. O. Wolter. "Ueber Myositis ossificans traumatica mit Bildung von Lymphcysten." (*Deutsche Zeitschrift für Chirurgie*, Vol. lxxv, p. 318. Ref. *Centralblatt für Chirurgie*, December 6, 1902.)

Extensor of thigh.....	2
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Dr. Graf. "Zur Casuistik der traumatischen Ossificirenden Myositis."

(*Archiv für klinischen Chirurgie*, Vol. lxxvi, p. 1105.)

Adductor magnus.....	1
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W. Mysel. (*Deutsche Zeitschrift für Chirurgie*, Vol. liv, p. 207. Ref. *Centralblatt für Chirurgie*, August 4, 1900.)

Brach. anticus.....	1
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Hoffmann. ( <i>Deutsche militärärztliche Zeitschrift</i> , 1902, No. 4. Ref. <i>Centralblatt für Chirurgie</i> , 1902, No. 37.)		
Brachialis anticus.....		2
Dr. F. Schulz (Rostock). ( <i>Beiträge zur klinischen Chirurgie</i> , Vol. xxxiii, p. 511.)		
** Schulz, Quadriceps.....		1
** Housell, Outer side thigh.....		2
Dr. Heinrich Schüler (Tübingen). ( <i>Beiträge zur klinischen Chirurgie</i> , Vol. xxxiii, p. 556.)		
** Deltoid.....		1
** Anterior of thigh.....		1
** Upper half femur.....		1
F. Munn. ( <i>Lancet</i> , 1891, Vol. i, p. 427.)		
Vastus externus.....		1
Orlow. Adductor longus.....		1
J. Hutchinson, Jr. ( <i>Transactions Clinical Society, London</i> , 1898-99, Vol. xxxii, p. 239.)		
Brachialis anticus.....		1
F. Eve. ( <i>Transactions Clinical Society, London</i> , Vol. xxxii, p. 232.)		
Circums and vasti.....		1
C. Lyel. ( <i>Traité de Chir. Clin. et Op. Le Dents et Delle</i> .)		
Demmler. Triceps cruralis.....		1
Orion.....		1
* W. J. Taylor, Philadelphia. Ant. thigh.....		1
* J. C. Oliver, Cincinnati. Triceps tendon.....		1
* W. G. Macdonald, Albany. Pectoralis major.....		1
* J. M. T. Finney, Baltimore. Gastrocnemius.....		1
* S. Marks, Milwaukee. Tendo Achillis.....		1
* McF. Gaston, Atlanta. Sartorius.....		1
* R. Matus, New Orleans. Cremaster.....		1
* E. Rivford, San Francisco. Adductor longus.....		1
* F. E. Banks, Cleveland. Rectus abdominalis.....		1
* S. H. Weeks, Portland, Me. Upper arm (seen very casually).....		1
* A. C. Bernays, St. Louis. Pectoralis major.....		1
* By courtesy of Dr. H. R. Howard, Massachusetts General Hospital:		
Service of Dr. Harrington. Flexors forearm.....		1
Service of J. W. Elliot. Quadriceps.....		1
Case reported by the writer. Outer side upper third thigh.....		1
Brach. ant. ....		1
Total number of cases.....		86

WEEKS, S. H. (Portland, Me.). Man, thirty to thirty-five years of age. Right hand and forearm caught between heavy cross rollers, which resulted in crushing the soft parts and breaking the humerus in two or three places. The fractures united, the soft parts healed, and he has a useful arm. The attending physician found a hard mass in the lower border of the pectoralis major between two and three inches from its insertion into the humerus. On examination, Weeks found in the free border of the muscle as it crosses the axilla a hard mass as large as a walnut, as dense and hard as bone. Diagnosis, myositis ossificans traumatica. Weeks only saw the case once.

HARRINGTON, F. B. (by courtesy of H. B. Howard, Boston). E. T. M., aged thirty-eight years, sailor. July 23, 1901.

*Past History.*—Good until fifteen months ago. Gonorrhœa; no pox; takes for past fifteen months; worse of late; lightning pains; partial blindness in right eye.

*Present History.*—Five weeks ago wrenched thigh; ecchymosis from knee to hip. When swelling of thigh went down he noticed a hard tumor attached to the femur high up; moves on moving leg; cannot walk without pain, nor can he walk in a dark room. Tumor has increased slowly in size.

*Present Examination.* . . .—Hard, nodular, irregularly rounded mass immovably attached to and on outer side of upper third of femur on the right side. Felt above Poupart's ligament. Does not fluctuate. No tenderness.

*Operation, July 27.*—Incision three inches long made over prominent part of tumor on front of thigh just above level of the trochanter. Small piece of tumor chiselled out. Tumor apparently developing in muscle sheath. Resembled normal cancellated bone.

TAYLOR, WILLIAM J. (Philadelphia). Man, aged twenty-three years; vigorous health; no rheumatic or specific history; is a horseman. On December 15, 1900, he was kicked by a horse on the anterior portion of the left thigh about the middle. The blow was severe, but, on being assisted onto his horse, he rode home. Intense pain; has ridden constantly since, though latterly insecure in his seat while riding a restless horse, as he could not hold on with his knees without pain. When seen, January 5, 1901, three weeks after trauma, there was marked swelling on anterior of thigh, over which the muscles rolled easily, but did not give a sense of a solid tumor, rather of an organized hæmatoma deep under the muscles. No pain except on certain movements, principally flexion of the knee.

*Operation, January 8.*—Incision. Swelling quite hard. The periosteum was broken down with quite a blood-clot beneath it, and certain of the muscles had apparently undergone degeneration, in which there were a number of small, hard masses resembling bone. The pathologist reported that the degenerative and necrotic changes going on in the muscles associated with the presence of newly-formed bone in the connective tissue led him to suspect that it was a myositis with a tendency towards the formation of new bone. No evidence of malignancy.