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<td>Underhill, T. Edgar</td>
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A Thesis

on

Spontaneous Fractures

by

J. Edgar Underhill M.B. R.C.S.E.

Surgeon to Queen's Hospital, Dudley.
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April 19, 1950

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That bones are liable to break without undue violence, and from causes quite disproportionate to the effects, has long been recognized and from a remote period has attracted the attention of Anatomists and Surgeons both in this and in other countries. Certain diseases, such as gout, rheumatism, scrofula, cancer and syphilis have been said to predispose more or less to the occurrence of fracture, but many cases have been reported in which there has been no diathetic tendency to any of these diseases, but fracture has taken place from simple muscular action, either in healthy bones, or in bones where there was some disordered nutrition associated with disease of the brain or spinal cord, or in those bones which were affected with mollities or fragilitas ossium.

On glancing through the literature of the subject, I have been struck both with the want of any classification, either clinical or pathological and also with the conflicting opinions expressed, by writers as to the nature of some of these diseases.

I purpose giving a short resume of our present state of knowledge of so called spontaneous fractures where the cause has been, 1st some tropho-neurosis, 2nd mollities ossium, 3rd fragilitas ossium, 4th simple muscular action, illustrating each group with at least one typical case taken from my own notebook.
The suspicion that lesions of the central nervous system have a direct action over the nutrition of the osseous parts appears to have been first aroused by Davy, who in 1842 reported a case of a female aged 33 who was admitted into Hanwell Asylum suffering from so-called "mollities ossium" in connection with some cerebral disease, the latter having existed two to three years before the condition of the bones attracted attention.

About three weeks before she died it was accidentally discovered that certain bones were broken. At the post-mortem examination six fractures were detected, two of the left femur, one of the right femur, one of the left clavicle (in which ineffectual attempts at union had taken place) one of the left humerus and another of the right radius. The medullary canals of the long bones contained a substance which both in colour and consistence resembled black currant jelly, it was totally devoid of the fat oily nature of the other secretion in the natural state. The cancellous substance of all the osseous system was apparently converted into this peculiar morbid product. The articulating extremities of the long bones were excessively vascular and very much softened.
Dr. Davy sums up with the following remarks. I am strongly disposed to think that independently of any chemical changes, so to speak in the osseous system, whereby the relative proportion of earthy and animal matter is lost, that there is a peculiar and specific disease of bone, the real nature of which is at present misunderstood.

At a later period the frequency with which fractures of the ribs were found in patients dying in lunatic asylums attracted notice; it was thought that these injuries were due to maltreatment by attendants, until the publication of numerous observations by Pedlar, Harder, and others showed softening and brittleness of the bones to be one of the elements of a tabetic condition apt to occur in the later stages of insanity.

Dr. Ormerod, in recording the results of his examination of the bones of two patients, one a case of acute mania, the other a case of general paralysis of the insane, who died in Sussex County Lunatic Asylum with fractured ribs thus described their appearance. They were dark, singularly wet and greasy and considering the short time that had elapsed since death, unusually advanced in decomposition; on pressure of the ribs dark blood oozed from the comparatively
large vessels on their surface. The medullary tissue was softer and darker than usual, the Haversian canals were dilated, and filled with an opaque granular material, in which were a few oil globules. There was no attempt at repair of the fractures. The process was essentially one of absorption of the internal structure of the bones, the osseous tissue being replaced by an excessive deposit of the fatty matter normally existing in its interior.

Dr. Armerod does not advance any theory that this condition of the bones is the result of the mental state, he rather suggests the idea that this mental and physical effect might be common results of the same cause and mutually independant.

From the description given by Dr. Davy I am inclined to think that his case was one of Involites Osseum associated with cerebral disease as a mere coincidence and not as a consequence, but in one at any rate of Dr. Armerod cases viz that of general paralysis, the nervous disease was probably the cause of the osseous changes.

Writing in 1873 on Rest in Hemiplegia Ataxia Dr. Hallpike says "I have suspected what has not yet been proved that the bones in Ataxies may suffer some impairment of their nutrition, and hence of their strength."
This suspicion has since been shown by Charcot to be correct, and the researches of Duchenne, Kerr, Volkman and others have established the fact that lesions of the central nervous system have a direct influence over the nutrition of the osseous parts.

And here it will be well for us to consider the grounds upon which these conclusions are based and to separate if possible facts from mere theories.

It is generally asserted that the bones of the insane are brittle and liable to break easily, but there is no evidence to show even if this statement was true, that the mental condition is the cause. In cases of simple Insanity, such as Mania, Melancholia, and Monomania, which may be regarded as merely functional, there is no reason to suppose that the nutrition of the osseous system is interfered with. Fractures may and do frequently happen to persons suffering from these forms of Insanity because from their restlessness, violence and erratic habits, they are much more exposed than sane people to the direct exciting causes of fracture.

For example in cases of Senile Insanity there is a great risk of fracture. Here there is a brittleness of bone but not more than may be seen in sane people of the same age; but in Senile Insanity there is usually great motor excitement, with increased restlessness.
restlessness especially during the night, and incessant interference with the people around them, and this, along with their unsteadiness on their feet, and their frailty, causes them very frequently to suffer from falls, or perhaps blows from other patients which may in them as in sane people result in fracture.

In cases of insanity however where there is evident structural lesion such as degeneration of the Brain or Spinal Cord there is no doubt that in many instances the nutrition of bone is seriously affected, as a consequence I believe of that lesion.

It has been shown by Charcot, Bramwell, and other writers that when the multipolar nerve cells of the anterior cornua of the Spinal Cord are destroyed, the anterior roots and muscular fibres to which they are distributed undergo rapid atrophy.

It has been observed also that after certain injuries of the central gray substance of the cord acute bed sores have formed showing that probably these are trophic centres for muscle and skin respectively.

Again in cases of Infantile paralyses where there is acute destruction of multipolar nerve cells in the anterior cornua we find in addition to the atrophy of muscular fibres certain trophic osseous lesions which often last for life even in cases where the muscles recover completely in a few days.
In Locomotor Ataxia we have sclerosis chiefly affecting the posterior-external columns of the cord, sometimes extending to the anterior. Now in some cases of this disease the osseous system appears to be unaffected; but in others such as those reported by Dr. Charcot there can be little doubt that the brittleness of the bones was due to the lesion of the nerve centres.

Once more, in General Paralysis of the Insane, Westphal, Sullivan and Joffe have shown that there is gray degeneration of the posterior columns with increase of connective tissue, and that these degenerative changes may extend to other parts of the cord. Speaking of this disease, Dr. Lillo says, I have come to the conclusion that the osseous framework of general paralytics undergoes a change which renders it more friable and that thus under the simple pressure of the finger it is often possible to fracture the ribs at the autopsy.

It is true, he adds, that such is not observed in all cases of general paralysis but is more especially in those cases which show trophic lesions.

Mr. Amogani admits as proven a softening of the bones special to general paralysis. He says it is rarely in the limbs that the fractures are observed; almost always
it is a question of fracture of the ribs. Christian thinks this is evidence that the bones are not more fragile for otherwise it is the limbs which most often would fracture from falls. During a period of nearly seven years he had under his care 250 cases of general paralysis without a single case of fracture. At the Congress in Angelo of Shent stated that for 25 years he had charge of St. Luke's Asylum, and that during that time he had seen very few fractures and scarcely any in cases of general paralysis. M. Morél who was for 17 years physician to the female insane asylum at Shent never met with a single case of fractured ribs.

In a communication from my friend Dr. Turnbull on this subject he suggests that the apparent discrepancy in the evidence for and against the presence of trophic osseous disorders in cases of general paralysis arises from a confusion of different stages of the disease. He says: "In the advanced stage of General Paralysis, there is frequently a marked change in the ribs, in which much of the mineral matter is removed and the rib becomes little more than a mere shell of bone, containing gummos matter in its interior. In such a case, if the rib is taken out after death, it can be snapped by gentle force..."
with the fingers, almost as easily as a piece of chalk. There is no doubt that this change in the ribs occurs and I have seen several instances of it post mortem. In these cases we might expect that fractures of the ribs would be produced by very slight causes and would be frequent, but I have never met with an instance of fracture during life due to this condition and I incline to think that such fractures if they occur at all must be very rare. The explanation probably is that the change in the ribs comes on only when the disease is far advanced and when the patient is so far gone in paralysis that he is bedridden and cannot move about in such a way as to expose himself to risk of injury. What conclusions can we now draw from the facts which have been stated? In the first place there is no evidence that mere functional derangement of the nerve centres interferes with the nutrition of bone, but there is abundant evidence that degenerative changes in the spinal cord are so frequently followed by osseous lesions as to leave little doubt that they are the cause of them. In the present imperfect state of our knowledge it is impossible to localize exactly the centre which governs these lesions.
In a case of Dr. New Mitchell's of locomotor Ataxia with spontaneous fractures, sclerosis of the antero-lateral columns of the cord was discovered.

In three cases of Charcot's in addition to the sclerosis of the posterior columns there was atrophy of the ganglionic cells in the anterior cornua, he therefore believes that the centre governing bone nutrition exists in some of the multipolar cells in that portion of the cord.

On the other hand, Buzzard in a very able paper on pathie arthopathies alludes to three cases where there was no lesion of the anterior horns, he also points out that very extensive lesions in that part are frequently met with in cases of progressive muscular atrophy and in infantile paralysis where no change existed in the joints and bones during life.

He states that gastric crises are not common in laboris dorsalis, that in seventy cases there were only twelve with gastric symptoms, but that in thirty cases of labor associated with disease in the bones or joints, fourteen had gastric symptoms. From this he argues that in all probability the centre for bone nutrition is to be found in the medulla close to the nuclei of origin of the pneumogastric.

I do not agree with him as regards the relation of gastric crises to laboris arthropathies.
arthropathies. In the cases I have observed there has been an absence of any gastric symptoms. I am inclined to believe with Charet that a more extended inquiry will demonstrate a trophic osseous centre in the anterior cornua. All point of interest is the nature of these osseous changes.

Clinically we find that the bones become more brittle and consequently fracture from very slight causes; that the bones of the lower extremity especially the femora are the ones that suffer most and that as a rule these fractures unite readily and with abundant callus thus differing very materially from what is observed in mollieties ossium and in fatty degeneration of bone where reunion seldom takes place.

The case of W. B. which I am about to relate is of much interest. His father and mother were insane, he himself was at one time in an asylum, and he is now suffering from locomotor ataxia. He has a history of syphilis though I do not consider that that is directly responsible for the osseous changes, on the contrary, Holmes says that with the exception of ulceration, syphilis renders bones not more, but less brittle. Possibly it may have been an indirect cause by inducing the degenerative changes in the cord.
W. B., aged 42, an ironworker, was admitted to the Queen's Hospital under my care on Dec 19, 1883, suffering from a simple fracture of the right femur. His father died in a lunatic asylum where he had been confined 14 years. His mother was likewise in an asylum for some years but is now apparently sane and well. There is no history of any member of the family having suffered with broken bones.

Patient himself has been married 18 years and has had 11 children. 7 are now alive; shortly after marriage he had a mild attack of syphilis which speedily yielded to treatment. Ten years ago he began to suffer with darting shooting pains in the lower limbs especially on the right side. He thought it was due to rheumatism but though the pains at times were very acute they were not sufficient to prevent him following his employment.

In September 1897 he was admitted into the Stafford County Asylum suffering from melancholia, but was discharged cured in October 1898.

From that time till his admission to the Queen's Hospital, he continued his usual occupation, although sometimes suffering considerable pain in his right thigh. On the morning of Dec 19, as he was walking quietly home from work.
work, he heard something crack, and at the same moment he fell to the ground. He tried to rise three times but was unable to stand as his leg bent under him like a cane. There was very little pain. His fellow workmen who were with him carried him to the hospital.

On examination I found the right thigh much swollen, especially in its upper third; there was a transverse fracture through the middle third, the foot was everted and the whole leg was about 2 inches shorter than the other leg. Manipulation of the limb appeared to give no pain. Sensation in all parts of the limb was greatly impaired. One curious feature was that when lying in bed he could raise his leg a little, and when I lifted the extended leg to an angle of 90° he could keep it in that position for a short time and then gradually lower it down. I have never yet seen any person with a fractured thigh able to do the same thing.

My first impression was that he had some form of malignant disease in the upper part of the thigh, but I found afterwards I was mistaken. The bulk of the swelling was entirely above the seat of fracture, and on enquiry the patient told me that he had noticed the swelling for some time. I applied a weight and pulley and sand bags laterally.
Abundant callus was formed and at the end of 8 weeks there appeared to be firm union. He was allowed to sit in a chair by the bedside for a short time one day but in moving himself he refractured his thigh. At the end of another 7 or 8 weeks he was allowed to get up with a plaster cast on, union being firm. The lightning pains from which he had suffered for so many years almost disappeared, when he met with his accident and they have never returned to the same extent. He says that breaking his thigh took his pains away and that even immediately afterwards, there was far less pain than before.

When in the hospital I noticed his left ankle was slightly swollen but painless. After leaving he was able to walk 2 or 3 miles with a stick but could not work.

On Sept 25th he was admitted into the Queen's Hospital Birmingham under the care of my friend Mr. Jordan. His condition was as follows. Left ankle much enlarged but painless. Skin warmer. Pupils unequal, left smaller; responds to accommodation but not to light (Coghill Robertson phenomenon). Knee jerks absent; superficial reflexes almost gone, right plantar most appreciable. In unaffected by ataxic position. Measurements of both thighs were:

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<td>Circumference of upper third of thigh</td>
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March 27 1885. Patient comes occasionally to the hospital to be inspected. He is much stronger, has gained 10 lbs in weight, relief present. Left cremasteric best, Plantar much weakened, walks with eyes closed. A peculiar cracking in right hip, none in ankle. Loss of pulmonal capacity than formerly. Pupils unequal, left larger, responds slowly to accommodation. Fundi healthy. June 1885. Left ankle painful and greatly swollen from roots of toes to knee, redness, oedema of parts, no synovitis could be made out, was confined to bed for some weeks. Sept 1886. Left ankle two inches larger than right, painless, great thickening of lower ends of Tibia and Fibula. No pain or movement, can walk a mile or two but soon gets tired. Loud cracking at times in right hip, right pupil contracted. Left dilated, can walk with eyes shut, but cannot at once place his finger on the tip of his nose. The characteristic lightning pains from which patient suffered so much before his accident have entirely disappeared. They seemed to leave him immediately after his thigh fractured. The same phenomenon has been observed by Neir Mitchell in several of his cases and he attributed the cessation of pain...
pain to the rest-in-bed which became necessary.
I cannot accept his theory as the sole cause of these peculiar pains disappearing.
I believe that the solution of continuity in the bone was a much more important factor.
I am indebted to Mr. Turnbull for the following notes of a case of spontaneous fracture occurring in a woman who was an inmate of the St. John's and Kinross Asylum, when I was resident there some years ago.
B. J., aged 28 was admitted to the asylum in 1869 suffering from Hysterical Insanity.
Family History: none.
Previous History: Twelve months ago she received an injury to the left hip and has been lame ever since. Has never had any broken bones.
On examination, she appeared to be suffering from an old standing unreduced dislocation of the left hip. Her mind was much enfeebled and she had fixed delusions that her body was being practised upon by mysterious agents in various ways.
About 1861 her bodily health began to suffer. She had great difficulty in walking about and complained frequently of darting, shooting pains in the legs which caused her at times to fall to the ground.
December 1882, whilst making her bed, she fell and sustained a fracture of the left tibia and fibula, a little way above the ankle. No one was present; and at the time it was thought that probably patient had fallen with her foot doubled under her in some way. She made no complaint, was able to raise herself, and actually went about for a time with the broken leg; and it was only when swelling came on that examination was made and the fracture detected. The tibia united well, but in the fibula only ligamentous union was obtained. From the state of the limb it was not possible to secure complete fixation of the fragments.

May 1884, patient was taking her usual walk, and then sat down on a bench. In rising again, she gave a scream of pain, fell, and had to be carried into the house; she afterwards said that on rising she felt something give way. A fracture of the right femur at its middle was found. It united firmly with a great quantity of callus. Patient’s health gradually broke down, and she died in September 1885, having been bedridden for a considerable time before her death.

Post Mortem
Advanced softening of spinal cord was found.
Mollities Ossium. By this term is meant a condition in which the bones of the skeleton become by degrees decalcified, causing an abnormal pliancy, so that they can no longer sustain the weight of the body but bend or break on slight provocation.

The pathology of the disease is at present rather obscure, possibly because as Holmes suggests, authors have confounded several different conditions under the same name. Some indeed make no distinction between pagodes and mollities ossium, while others regard mollities ossium as an affection allied to rickets. No doubt it resembles this latter in being the expression of a general disease or at least a morbid state of the osseous system, and not a mere local or accidental disturbance of nutrition in one bone or group of bones; but the essential difference is that rickets is a disease of the osteo-plastic tissues, in consequence of which the newly formed layers do not become properly ossified and remain soft. Mollities is a disease of fully-formed bone, causing its tissue to melt and become soft.

Its anatomical characteristics are a gradual decalcification of bone, the changes commencing in the long bones in the medullary canal and then extending to the medullary spaces and Haversian systems of the cancellous tissue, and passing by imperceptible gradations into the normal compact bone tissue.
In the short and flat bones the cellular spaces of the diploe expand and coalesce to form larger cavities. The cortical layer is thinned and its Haversian canals are dilated. The medulla has an extremely congested appearance in the early stage of the disease, but afterwards it becomes pale and assumes a yellow, honeylike or oily aspect.

Some writers speak of an osteomalacia rubra et flava but according to Tonnard this difference of tint indicates not a difference in the form but only in the stage of the disease. Under the microscope the capillaries of the affected medulla in the central canals, cancellous spaces, and Haversian canals are greatly enlarged. They are embedded in a soft gelatinous substance composed of a homogeneous basis containing embryonic cells, some of which are filled with large fat drops. There are besides pigment granules and free blood corpuscles.

This decalcified matrix presents the same appearance and behaves in the same way to reagents and staining fluids as the tissue left after the removal of the earthy salts from a normal bone by acids.

Billroth quoting from Kilian speaks of this process as "halistesesis ossium" and considers it in the highest degree probable that the lactic acid which has been found by Weber, Schmidt and other observers in...
the medulla of the cylindrical bones dissolves the salts of lime which are carried into the blood and pass off in the urine as oxalate or phosphate of lime.

On the other hand Durhan is inclined to regard the presence of lactic acid rather as a phenomenon of the disease than as a cause, and quotes in support of his view cases recorded by Fray, Virchow and Lehmann in which they were unable to detect any lactic acid in the bones.

I think it is probable that a more extended enquiry will show that lactic acid is present at a certain stage of the disease not as a cause but as a result of the morbid process.

Osteolysis ossium is a rare disease especially in this country. It occurs in certain parts of Europe more particularly in Germany. It affects women almost exclusively. Commencing generally after one or more pregnancies and therefore those who suffer from it are usually between 20 and 45 years of age. It is much more common amongst poor people and especially when living in a damp house or locality.

Hereditary influence does not appear to play any part in its production. A deficiency of earthy salts in the food has been spoken of as a cause but there is no evidence to support such a view.
The contrary in one case under my own observation, the patient was living on the limestone. The drinking water was extremely hard and urinary calculi were very common in the district.

Symptoms. Patients usually complain first of aching dragging pains in the pelvis and spine. There is an increased difficulty in sitting or walking. They assume a stooping position, and feel unable to straighten themselves. Distortion of the spine and pelvis soon takes place, the latter appears to be compressed from side to side causing its transverse diameter at the outlet to diminish, and the former seems as if it were pushed down into the pelvis causing the promontory of the sacrum to be projected forwards, and the whole body to become appreciably shorter. If pregnancy occurs the pelvic deformity naturally gives rise to extreme difficulties in delivery.

In many cases the progress of the disease appears to have been checked for a time, but another pregnancy or some unknown cause apparently lights up the morbid process, and it commences to invade other parts of the body. It usually extends upwards to the ribs and sternum and downwards to the femora and tibiae, rarely affecting the bones of the cranium, carpus or tarsus.
The softening of the bones gradually manifests itself by the occurrence of distortion. The weight of the body causes both lateral and angular curvatures of the spine. Fractures partial or complete follow the slightest injuries. The ribs bend and break from the pressure of the arms causing trough-shaped hollow in the axillary line.

There is often extreme pain from the least movement and death gradually ensues either from wasting or from asphyxia the result of a compressed thorax, or possibly from some operative measures undertaken to terminate a pregnancy.

As regards treatment there is little to be said. The only prophylactic measure that can be recommended to women who already show signs of the disease, is to avoid all risk of renewed pregnancy. No remedial measures, as yet discovered, have either arrested the progress of infirmities ossium or promoted its cure.

Our chief attention must be directed to the improvement of the hygienic surrounding of the patient, especially to her removal from the deleterious influences of damp. Further, we may try to strengthen her general health by appropriate diet and tonics, such as cod-liver oil and iron.

The following case appears to be a typical example of this disease though the patient lived a longer time than is usual from the first appearance of the
In aged 39, widow, Dressmaker came under my observation in July 1853 as a case of Mollities Osseum.

Father, healthy, mother, sister and brother died of Tuberculosis. None of the family showed any tendency to bone disease of any description.

Up to the time of her present malady she enjoyed uniformly good health, was in comfortable circumstances and was of an even disposition. When her husband died she had to work hard with a sewing machine to support herself. She then worried excessively and became very irritable and sensitive although she never suffered any privation, nor was she ever exposed to the influences of cold and damp.

She has had five children, the eldest who is now 18 is gradually wasting away from Tuberculosis, the youngest is 11.

Her labours have been fairly good excepting the last which was a very long and difficult one, no miscarriages.

In the early part of 1856 she began to suffer with aching pains in the lower part of the back and in the pelvis. She had a mucous purulent discharge from the Vagina for which she consulted a surgeon who told her she had uterine disease and treated her accordingly.

As she continued getting worse Mr. Parse of Brierley Hill was sent for and she
has been under his care to the present time. She found nothing the matter with the uterus but noticed that she had lateral curvature of the lower dorsal and upper lumbar vertebrae. She kept her in the recumbent position for 9 months and gave her various tonics.

March 1879. Patient appeared much better. The spinal disease seemed to be held in abeyance; she began to do a little light housework. However, after a time the pain which had disappeared whilst she was lying began to return again and a porous plastic jacket was applied. During the next few months she went about with great difficulty the pains getting worse and more widely spread. Her friends noticed that she was getting shorter; her head seemed to be sinking between her shoulders and her spine was pushed down into the pelvis. Menstruation was regular, appetite fair, bowels rather confined, urine normal, no increase of phosphates.

In the beginning of 1879 her left leg became oedematous and very painful and she took to her bed again, never leaving it till the time of her death. April 2nd 1879, whilst being raised to have her bed made her left femur suddenly fractured about the centre of the shaft. The thigh was immobilised and kept so for a couple of months but no attempt at union took place. Other bones under
the slightest provocation and at intervals of two or three months gave way in the following order; right femur, left tibia and fibula, and then the corresponding bone on the other side. Beyond an aggravation of the above mentioned symptoms nothing occurred that called for any note until early in 1882 when the ribs in the mid-axillary line presented a groove, where they were bent inwards by the pressure of the arm to the side, and the normal curves of the clavicles were much increased. This altered shape of the upper part of the chest evidently compressed the nerves and axillary vein, for the right arm became oedematous and the state of great pain in September of the same year the pelvis became noticeably contracted both in its transverse and antero-posterior diameter. From this time the progress was extremely slow indeed the disease seemed to be quite at a standstill.

July 1883. Patient now is a pitiable object, she complains of intense pain in the back and down both legs; the latter are oedematous as is also the right arm. The ribs have fallen in on each side and are beginning to compress the lungs, her intellect is quite clear and her memory good. There is a trace of Albumen in her urine and she has an
almost constant offensive discharge from the vagina, at times there is a good deal of haemorrhage. As it was necessary to make her bed and change her linen, I administered Chloroform. Whilst she was under its influence I examined the fractures before mentioned and found there was no trace of union in any of them. During the next few months I administered Chloroform on several occasions when it was necessary to change her linen, as she could not bear the slightest movement without it.

1885 She gradually became weaker and more emaciated, her appetite failed, she became sleepless and irritable at night and subject to profuse perspiration. The bowels became relaxed, the respiration gasping and hurried, the sterno-num softened and fell in and she died on May 2 1885 apparently from the simple inability to breathe longer. Her mental faculties were unaffected till the end and at times she was quite bright and lively.

Post Mortem 66 hours after death
Her body presented a most pitiable sight. Emaciation especially of the trunk and face was extreme, her legs being still somewhat oedematous did not appear so wasted.

The chest and pelvis I find very difficult or almost impossible to describe in order to give a clear idea of anything approaching...
the real state. They were both considerably flattened from before backwards. The ribs were drawn close together some overlapping the others, and at the sides instead of following their usual curve they projected as sharp and irregular points. On nearing the sternum they were seen to suddenly dip backwards, then curve at an acute angle and come forwards again. In passing inwards to reach the sternum they had to ascend almost vertically at parts, because it was altogether on a higher plane than the front part of the ribs.

It was only the manubrium and the upper part of the 2nd piece of the sternum that had fallen in. From about the articulation of the third rib (where there was a fracture) the sternum was considerably bulged. The clavicles were intact much shortened in length, but the curves which at one time were greatly increased had now become less, giving the bone a straighter appearance than usual, and while manipulating the shoulder to examine the humerus each clavicle in turn gave way. The bones of the arm, forearm and hand although much attenuated were quite strong and apparently healthy. The pelvis was much distorted, so much so that when two fingers were introduced into the vagina they were gripped by the bones of the brim. The ilia were turned very
much outwards and absolutely devoid of any firm osseous tissues, so that they could be bent in any fashion desired, resembling very much the feel that would be given by moistened pasteboard under the skin. The face bones were unaffected and the teeth were good.

The head preserved its normal form; the parietal bones were softer than the remaining bones of the skull but only soft to a very slight extent in comparison to the other bones of the body.

The spinal column was much distorted, not only were the normal curves exaggerated but lateral curves and rotation of the vertebrae were added. Besides these the individual bones seemed squeezed and almost matted together.

The legs were shortened and the thighs curved but had been prevented, by sand bags and pillows from assuming any very marked deformity. All the bones of the skeleton excepting those of the arm and head could be cut easily with an ordinary scalpel. They were light and soft. Some of those that were more advanced, seemed to be composed merely of a gritty membrane. A 2nd lot were formed of very thin shells which would snap with the greatest ease; and a third variety were found to possess to all appearance the usual amount of compact tissue, but it was of much less dense nature.
The interior of the bones instead of being filled with the usual cancellous portion, was replaced by an opaque, thick granous substance, of a reddish-brown colour. The lamellae which form the reticular or cancellous portion having almost entirely vanished.

Over and around the situations of the fractures the soft parts were much thickened and infiltrated with bony material. The periosteum was much thickened and slight bony deposits were found scattered about in the neighbourhood of the fractures, on the old shells, but there was no reunion of the fractures.

Other organs healthy except the uterus where there was evidence of chronic endometritis.

Microscopic examination.
The bony laminae seemed to be disappearing rapidly, apparently absorbed by the cells of the granulation tissue which filled up their interstices. Amongst this granulation tissue there were a large number of osteoblasts which seemed to take an active part in the absorption; the bone corpuscles appeared to be perfectly inactive; they were not proliferated. The lacunose canals were enlarged. There was no increase of fat. It presented all the appearances of a subacute inflammation of bone.
Paget looked upon mollieties ossium as a fatty degeneration of bone which may and does occur in men, as well as in women. By the description which I have given, it is evident that I do not share his views. I think the term ought to be confined exclusively to the disease which I have described and that the cases which Paget alludes to should be classed as cases of fatty degeneration of bone and not as instances of mollieties ossium. The clinical history of the two classes is different. In the former, the disease affects men as well as women, and the bones of the extremities more than those of the trunk. The latter affect women almost exclusively, and that between certain ages, and nearly always commences in the spine or pelvis.

In the former the pathological condition is a fatty metamorphosis, in the latter there is little or no increase of fat. There is not sufficient evidence at present to say whether either of these diseases arises from degenerative changes in the spinal cord. Now that attention has been called to the relation between nerve and osseous lesions, we must accept with caution the classification of cases by older writers and not perpetuate their errors by citing them as instances of one disease or another unless we have before us sufficient evidence to warrant our conclusions.
Fragilitas Ossium: By this term I mean a diseased condition of the bones in which they are extremely fragile, so that they are liable to fracture from very slight causes. Holmes says it would be well if the term 'Fragilitas Ossium' were allowed to become obsolete, since it only describes a symptom common to several affections. Ho doubt he is right as regards many cases described under that head which might be more correctly classed as instances of atrophy, fatty degeneration of bone, etc. But there are some cases such as the one I am about to relate which seem to require a distinctive name and as he does not suggest one, I am compelled to place it under the term which best describes the most prominent symptom.

For my own part I believe that that mysterious power which in our ignorance we call by the unscientific name of hereditary influence, plays an important part in the production of this condition. Numerous cases are recorded where certain families have been noted for the brittleness of their bones and this apart from any degenerative changes in other parts of the system, it has often been ascribed to the
poison of syphilis but as I have remarked elsewhere there is a lack of evidence to show that syphilis causes bones to become brittle.

A few months ago I saw a strong muscular man aged 28 who was suffering from a fracture of the lower third of his right thigh. He was skating one day when suddenly his thigh snapped and he fell on the ice. A few years before he broke the same thigh in exactly the same way only the fracture was higher up. On both occasions union took place rapidly and firmly.

My attention has lately been called to the case of a man aged 38 living in this district who received a fracture of the shaft of the humerus by his brother suddenly grasping his upper arm. The bone snapped with a loud crack. In this instance no union took place and he has since had his arm amputated.

As a rule in cases of Fractilitas Ossium, the fractures unite readily. The above was an exception, probably I think from the very drunken habits of the man.

The following case I have classed under the head of Fractilitas Ossium for want of a more distinctive name.
Eliza Ensor, aged 66, admitted to the Guest Hospital on Sept. 6th 1884, suffering from a fracture of right thigh.

Father and mother were both strong and healthy and are said to have died of old age: the father aged 85 and the mother aged 80. No history of broken bones in the family on either side.

Patient is one of 12 children, six of whom were born with some deformity of the legs. Two or three of them were never able to walk, but were obliged to crawl about on their hands and knees. They have been noted as a family for their brittle bones.

The history is imperfect as patient is unable to remember much about her family and is likewise extremely deaf.

All of her brothers and sisters are dead with one exception. She above has been told me by her neighbours.

Excepting the broken legs and occasional rheumatic pains in various parts patient has enjoyed good health. From birth of diminutive stature, but in no way deformed as many of her brothers and sisters she is married and has had 18 children and 6 miscarriages. None of her children lived to be more than 15 months old and none of them suffered from any skin eruption or snuffles. No syphilitic history of any kind can be obtained.

The day she was admitted to the hospital she was stretching up to lift a dish from
a shelf above her head when she fell something crack and immediately she fell to the ground.

On admission she had a simple fracture of the right thigh in its upper third. Both thighs were very much bent in a direction outwards, and forwards, in their upper thirds; the left thigh has been broken once previously, and this is the third time the right one has given way. In each case the cause has been tripping. The deformity in the right is much greater than in the left thigh and it is also two inches shorter. Eupites is readily obtained. Extension to the thigh does not in any way influence the deformity. After being in hospital about 5 weeks, as there appeared to be good union, she was allowed to get up; she could stand but could not walk. One day as the nurse was carrying her from one ward to another the door was not quite wide open so she pushed it lightly with her right foot and the thigh immediately snapped again.

She was treated as before with a weight and pulley as extension, and sandbags laterally. Ominous callus was formed on both occasions. After the end of 9 weeks she was allowed up and when she left the hospital in March 1885 she was able to walk fairly well with the aid of two sticks.
Jany 27th 1886 Patient is now completely bedridden since she went home her left thigh has broken three times. It is now about the same length as the right one. The fractures which have been through different parts of the shaft of the bones have all united. No other bone in her body has ever been broken.
In addition to those morbid conditions which predispose to brittleness of the bones and which often result in spontaneous fracture, there is another class of cases where as far as can be ascertained the bones are perfectly healthy, and yet they give way apparently by simple muscular action.

From their position, certain bones are much more likely to be broken in this way than others, and thus we find the patella, humerus, olecranon process of ulna and femur are comparatively often fractured by the action of muscle whilst other bones such as tibia, radius and ribs seldom suffer in the same way.

It is hardly surprising that the patella should at times be broken spontaneously when we consider its situation and the power of the quadriceps extensor femoris inserted into its upper border.

Muscular action does not appear to produce the effect by tearing the bone apart, but by the pull exerted upon the upper portion of the bone, while its lower part is fixed by the ligamentum patellae, and the resulting leverage over the lower end of the femur, according to this theory the fracture is due like so many others to "cross-breaking strain".

Hamilton has recorded 127 cases of fracture of the patella and he expresses the opinion that muscular action was
more or less efficient in causing the fracture in all the simple transverse and in at least one of the comminuted fractures, that is to say in 107 out of 127 cases.

According to Packard, re-fracture of the patella, is not a very infrequent occurrence as he says sometimes but rarely the bond of union gives way; more frequently the bone separates at another point. From my own experience I should have said that the bond of union giving way is the more common accident.

In Hamilton's series of cases there were twenty seven in which the fibrous band gave way, although it is true that most of these were within a few weeks of the primary accident and soon after leaving off their apparatus.

Dr. Little reports the following case: M., aged 22, broke his left patella transversely below its middle in March 1879. It united by fibrous tissue with a separation of half an inch. About five and a half months later he slipped in walking, and the same patella was found to be fractured at a point about half an inch above the first fracture and transversely. Parson has published a case where in December 1874 the left patella was fractured at the junction of the middle and upper thirds, in October 1880.
the same bone gave way at the junction of the middle and lower thirds, and in August 1882 it was again broken at the same point.
The following case is at present under my care.

History

J.S., aged 40, a labourer, was admitted into the West End Hospital on Jan. 30, 1886, with a fracture of the right patella. Three years ago he fell on his right knee sustaining a transverse fracture of the right patella at the junction of the middle and lower thirds. This united by a fibrous band of about ¾ an inch. Since then he has been able to walk well and when necessary to work in a kneeling position without much inconvenience. As he was returning from work this morning he slipped but did not fall. He heard something crack and his right knee became very painful.

On examination, I found his right knee much swollen and a simple transverse fracture at the junction of the upper and middle thirds of the right patella. The fibrous band uniting the old fracture was entire. I drew the fragments together with strapping and placed the leg on an inclined plane. It is now going on well. From this and similar cases I am of opinion that a fibrous union of not more than ¾ of an inch in length is quite as advantageous as a bony union.
union and probably much stronger and that the operation of suturing the fragments is only justifiable in cases of compound fracture and in those cases of united fracture with absolutely useless limbs.
The records of surgery furnish many examples of fracture of the shaft of the humerus from muscular action, in fact, if we except the patella, we find that as an exciting cause, muscular contraction more often produces fracture in the humerus than in any other bone in the body.

In an interesting communication to the Philadelphia Medical Times Dr. Hopkins explains the reason why this bone is liable to break under certain circumstances. He says: "When the forearm is flexed at the elbow joint, by the contraction of the muscles of the arm, the lower end of the humerus acts as the fulcrum; the biceps and brachial muscles as the power, and the hand, with whatever it may grasp, as the weight. The forearm is, in other words, a lever of the third kind. In such the power must always be greater than the weight, technically expressed by the phrase, mechanical disadvantage. The amount of mechanical disadvantage to which the muscles of the arm are put to raise a known weight placed in the hand, is computed by multiplying the weight to be raised by its distance from the fulcrum, and dividing the product by the distance of the power from the fulcrum.

The following measurements were taken from the bones of a well-developed male skeleton, from the bottom of the sigmoid cavity of the

[The text continues on the next page]
ula to the metacarpo-phalangeal articulation of the middle finger, fourteen inches, and from the same point to the tuberosity of the radius, two inches. For convenience in Amputation the attachment of the biceps alone will be used, as it is the more important flexor muscle, and as it presents less mechanical disadvantage than the brachial. The power then in this lever is to the weight as seven to one. If therefore, a weight of one hundred and fifty pounds is raised by the hand by flexing the forearm, the power exerted by the muscles in executing this movement is represented thus: $14 \times \frac{2}{3} = 1050$ pounds a force well calculated to part a tendon or break a bone.

The fact that the forearm cannot be extended with as much force as it can be flexed, though with greater velocity, of course depends upon the difference in distance between the power and the fulcrum in the two cases. For, in the same specimen, the distance from the point of insertion of the tendon of the triceps in the olecranon to a point opposite the bottom of the semilunar cavity of the ulna was found to be only half an inch. The power then, in this lever, is to the weight as twenty-eight to one. Therefore, when a sixty-pound dumb-bell is put up from the shoulder, the force exerted by the triceps muscle is shown thus: $14 \times 60 = 1680$ pounds, or 630 pounds more force than is required to raise 150 pounds by flexion.
In the same article Dr. Hopkins reports three instances of the fracture of the humerus by muscular contraction. In one, the patient was throwing a base-ball over hand; in a second, the man made a miss in striking a hard blow at another with whom he was fighting; and in the third, a woman was carrying a heavy bit of clothes.

Gross met with three cases in which the humerus was fractured in precisely the same way, he says, the subjects were remarkable for their health and muscular development and the fracture in each was produced while they were engaged in feats of strength in which the elbows were planted firmly upon a counter and the hands interlocked with each other. While the muscles of the arm and forearm were in a state of the utmost tension, the humerus snapped off suddenly with a loud noise; in two cases at its middle, and in the other at its inferior extremity.

Many other writers have recorded cases of a similar kind in which the humerus has been broken in trials of strength. In my own experience I have only met with one instance of this injury and as that occurred in a manner differing from all others I have heard of I have thought it worth while placing it on record.
History

\( W \) aged 31 an ironworker, a strong healthy man, with no history of syphilis, or of any hereditary predisposition to brittle bones, was engaged on the morning of Nov 3rd 1883 in cleaning out his puddling furnace, a place about the size of a baker's oven only with a rather larger aperture. Having finished his work inside, he was pushing himself out backwards on his hands and feet (or more strictly speaking on his toes) when suddenly his left upper arm gave way, and he fell forwards on his face. A fellow workman extricated him from his unpleasant position, and brought him to my consulting room shortly afterwards.

On examination I found the left upper arm greatly swollen and very painful and a simple transverse fracture through the shaft of the humerus just below the middle. I applied a right angled potoplastic splint and union took place rapidly and firmly. He has since been able to follow his usual employment and his left arm is now as strong as his right.
Fracture of the Ribs from muscular action is not so rare an accident as some writers think. It is not easy to understand the mechanism of such lesions unless we suppose that they are the result of a sudden pull by the extra-thoracic muscles, as by the serratus magnus (its lower part being fixed). Coughing has been the action to which these accidents have been most frequently due, the portion of the chest involved having been near or below the middle, and more often on the left side.

Malgaigne has collected eight examples of fractures of the ribs produced by muscular action, by the beating of the heart, etc., all of which occurred upon the left side. A case is related by Castella in which a fracture of the ninth rib on the left side was caused by sneezing. Despres and Tonell relate cases in which ribs on the same side were broken by coughing. Paulet collected six cases in which the fractures were on the right side, three by coughing and two by a sudden movement of the body.

The following case occurred in my own practice, nearly two years ago, and was published by me at the time (Vide Lancet, June 28, 1884).

K. B. — aged fifty-four, a strong and very muscular man, was engaged on April 12th, 1884, in demolishing a brick kiln by means of a sledge-hammer which weighed a
little over eight pounds. He was working in a narrow part with only just enough room to give his hammer its full swing, when suddenly he missed his stroke from the hammer catching against the side of the kiln, and was twisted violently round, causing intense pain in the left side of his chest.

On examination, a few hours afterwards there were no marks of external violence but there was unmistakable fracture of the sixth, seventh and eighth ribs on the left side, a little in front of the angles; the man himself complaining of a sensation like "two rough bricks rubbing together." He is confident that the injury was caused by indirect violence, and not from being struck with the handle of the hammer or from falling against the side of the kiln. Cases of fracture of the ribs from muscular action; according to Malgaigne never occur except where there is some atrophic thinning or other morbid change. In the present instance there is no evidence of pathological brittleness in any bone; on the contrary although at different times in his life he has met with serious accidents, he has never had a bone broken. In his own district he is notorious for his strength and muscular development, and, although past middle life, has shown none of those atrophic and degenerative changes which generally accompany advancing age.
Fracture of the radius alone by muscular action is an extremely rare form of accident especially when it occurs in its upper third. I have only been able to find one case of this nature.

Dr. Packard reports as follows: "In 1856 I saw a case under the care of J. Millot, in Baltimore in which the radius had given way very high up, as the patient was pulling very hard, in driving a pair of horses. I do not know of any other recorded case of the kind, but the history of this one was clear, and the mechanism may be easily perceived, the twist impressed upon the bone by the action of the biceps was such as to overcome the strength of the tissue."

The following case occurred in the same works where the man W— sustained a fracture of the humerus as reported on page 45.

E—S— aged 25, an ironworker, a strong and muscular man, with no history of syphilis or of predisposition to brittle bones, was at work on Jan. 10th 1883 in front of a furnace pushing in pieces of iron with a pair of tongs. Suddenly someone shouted to him to look out and he saw a piece of iron coming from the steam-hammer apparently at his head. He instinctively threw up his left arm with a sudden jerk.
to protect himself, but the iron passed some distance over his head. He immediately complained of pain in his left arm and came to consult me about it. He said, "I have strained my arm by a sudden jerk."

On examination I found his left forearm swollen and every sign of a simple transverse fracture through the shaft of the radius about the junction of its upper and middle third. The crepitation was very distinct. By keeping the forearm supinated and semi-flexed I obtained a perfect result.