REMARKS UPON OSTEO-MYELITIS
CONSEQUENT ON
GUNSHOT-WOUNDS OF THE UPPER
AND LOWER EXTREMITIES,
AND ESPECIALLY UPON THE
TREATMENT OF STUMPS AFFECTED WITH OSTEO-MYELITIS
AFTER AMPUTATION NECESSITATED BY SUCH INJURIES.

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CONSIDERABLE attention has been given during the last few years, especially in France, to one of the special consequences of gunshot wounds of bones, of considerable interest to military surgeons. I refer to the inflammation which is set up by these injuries in the medullary membrane, that fine vascular tissue which lines and fills the central canals of long bones, and which is continued from them into the cells of the cancelli and the Haversian canals. As is well known, it is by means of the vessels ramifying upon the meshes of this connective tissue that not only the oily substance called

the medulla, which the tissue encloses in all directions, is secreted; but also, in conjunction with the vessels of the periosteal investment, that those changes which are required for the proper nutrition of bone are effected. The tissue which lines the cells of the flat and irregular bones and which corresponds in function with that of the long bones, though modified in certain respects to suit the special characters of the former, appears to be equally subject to the inflammation to which I refer under similar circumstances; but it is to it, as it occurs in long bones, that the attention of surgeons has been particularly directed of late, because it is in them that it has assumed a character of importance in respect to the practice to be adopted in the after treatment of gunshot fractures, especially when the diseased condition of the bone has so far advanced as to lead to the necessity of the removal of the limb or stump involved in the disease, by amputation in its continuity or by exarticulation.

It is not believed that any essential difference exists between the nature of the inflammation of the medullary tissue when developed by gunshot wounds, and the inflammation which occasionally arises after the ordinary injuries and amputations of civil life; but it is its comparative frequency after gunshot injuries and after amputations consequent upon them, in men of previously sound constitutions in military practice, contrasted with the comparative rarity of its occurrence in patients of sound constitution in civil practice, that has caused attention to be so much directed to it and to its proper treatment by army surgeons.

The name *Osteo-Myelitis* has been employed by French and English surgeons for the purpose of defining this inflammatory action and the particular direction in which its influence is mainly exerted. The term *Endosteitis*, used by some German writers (derived from "Endosteum," *ενδον*, within, and *οστεον*, a bone, a designation which we occasionally find used synonymously with our term "medullary membrane") seems to express better the special diseased condition intended to be signified, for it serves to mark more clearly the distinction between the endostitic inflammation

and that of *ostitis* and *periostitis*. Both terms are used indiscriminately in the course of this paper.

The subject of inflammation of the medullary tissue of long bones after gunshot wounds, and amputations resulting from them, has been specially investigated by several surgeons; but a French military surgeon who was in charge of one of the large hospitals at Constantinople during the Crimean war, Dr. Valette, and M. Jules Roux, the principal surgeon at the large marine hospital of St. Maudrie, at Toulon, have more particularly drawn attention to the subject.

Dr. Valette published a report¹ on the effects of osteo-myelitis among the wounded from the battles of the Alma and Inkermann who were received in the hospitals at Constantinople. An analysis of this memoir was laid before the Surgical Society of Paris. On studying this report the reader can scarcely help concluding that the so-called osteo-myelitis, in a large number of the instances referred to by Dr. Valette, must have been truly cases of pyæmic poisoning, and that, in all, the symptoms of the osteo-myelitis were greatly aggravated by circumstances tending to the development of pyæmia. Dr. Valette acknowledged the close association between the osteo-myelitis in these cases and pyæmia, and stated that purulent infection was a constant consequence of it; but he regarded it as a far more fatal disease than pyæmia, which occasionally was recovered from, while osteo-myelitis, he asserted, had killed every one who had been attacked by it. The local morbid changes produced by the disease were found by Dr. Valette to vary according to two stages: in the first stage, the medulla was observed to be intensely vascular and increased in density; in the second stage, there was purulent infiltration of the open tissue, with small deposits of pus in the medullary canal. Associated with the latter were generally found the usual signs of purulent absorption, as

¹ Valette Tharsile, Médecin-Major, "Mémoire sur l'ostéo-myélite des amputés," *Mém. de Médecine, de Chirurgie, et de Pharmacie Militaires*, 2me série, t. xvi, p. 230.

ecchymosis, abscesses in the lungs or liver, or deposits of pus in the joints, muscles, and other tissues. In a few cases no decidedly morbid changes were detected. The following is Dr. Valette's description of the local indications of the disease when occurring in a stump after amputation :

1st.—Protrusion of the medulla from the end of the divided medullary canal in the form of a grayish-coloured button-like protuberance ; 2nd, separation of the periosteum from the circumference of the lower portion of the divided bone ; and 3rd, protrusion of the bone between the lips of the wound.

The disease in its acute form generally commenced from the fifth to the tenth day after the operative interference, being ushered in by rigors and fever, perhaps nausea, vomiting, and typhoid symptoms ; delirium supervened, the skin became icteroid ; and the general symptoms which followed, and immediately preceded death, closely resembled those of purulent absorption. Death sometimes occurred rapidly, perhaps on the third or fourth day after the first appearance of the symptoms. Dr. Valette found all treatment ineffectual, such as the application of caustic substances or the actual cautery to the end of the bone, or its removal by the saw ; and he was consequently induced to advocate the same view, with regard to this acute form, that M. Jules Roux has since advocated with regard to the disease in its more slowly developed chronic form. He thought that all resections and amputations for excessive osteo-myelitis after gunshot fractures should be abandoned, and disarticulations substituted ; the wounded at the same time being scattered in tents as widely as practicable.

The observations of M. Jules Roux refer to osteo-myelitis in a more chronic form. M. Roux had under his care a very large number of soldiers who were wounded in the Italian campaign of 1859, about 2000, and a considerable number among these men presented diseased conditions demanding consecutive amputation, or other surgical interference, on account of the injuries they had received. In consequence of the large ratio of fatal results in the first eight amputations and resections performed, viz. six deaths out of the eight

cases, M. Roux was induced to try disarticulation of the diseased limb instead of its partial removal by amputation or resection, and this change in practice was attended with remarkable success.

The following is a summary of the arguments which led M. Roux to substitute the operation mentioned for amputation.¹ Osteo-myelitis, he says, of a more or less grave character invariably follows all gunshot wounds of bones, especially when the spongy tissue of broad and short bones such as the calcaneum, or the articular ends and medullary canals of long bones, are wounded; and the inflammation of the medulla ordinarily spreads, with more or less rapidity, throughout the entire bone. This osteo-myelitis in most cases yields to rest and treatment, and is cured; but if it assumes a chronic form, and removal of the limb becomes necessary, then secondary amputation generally only takes away a portion of the inflamed bone, and, in consequence of this incompleteness in the operation, the disease is aggravated in the remainder.² Hence

¹ 'Bulletin de l'Académie Impériale de Médecine,' 24 Avril, 1860.

² Some time after this paper was written, I received from Dr. Fayrer, Professor of Surgery in the Medical College of Calcutta, a pamphlet on 'Osteo-myelitis,' illustrated with histories of thirty-five cases, chiefly occurring in natives of India. This experienced surgeon, both in military as well as civil practice, has arrived at views regarding the treatment of osteo-myelitis closely resembling those of M. Roux. At page 5 of the pamphlet Professor Fayrer writes as follows:—"M. Roux has especially called attention to the subject of osteo-myelitis in connection with gunshot fractures, and the question of amputating above the joint, instead of through the injured bone. He recommends that disarticulation should be performed rather than amputation through the bone. His experience was obtained during the late French-Italian war. My own experience entirely confirms his views, and I may most confidently say that I had arrived at and recorded similar opinions before I had become acquainted with those of M. J. Roux. At first sight it certainly seems a harsh proceeding to amputate at the hip for a compound fracture of the lower third of the femur, but if by doing so the risk of purulent infection be lessened, there can be little doubt but that it should be done. I am not prepared to say that it is absolutely necessary, at once, in all injuries; but in secondary cases where re-amputation is needed, from the bone in the stump having become affected, there can be no doubt that, as a general rule, it is entitled to serious consideration."

chiefly arises, in all probability, according to the views of M. Roux, the failures of secondary amputation for gunshot wounds of bones ; and this also explains why, if after six months, or even a year, a surgical operation becomes indispensable, exarticulation, or removal of the whole of the diseased bone, is preferable to amputation in most, if not in all cases.

Acting on these conclusions M. Roux practised exarticulation in twenty-two successive cases, and with extraordinary success ; for, as shown in the report, the patient in every instance recovered.¹ The exarticulation of the limbs were performed at the following joints :

Coxo-femoral	4 times.
Scapulo-humeral	13 „
Femoro-tibial	1 „
Fibio-tarsal	3 „
Metacarpo-phalangeal	1 „
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Total	22 „

The principal question involved in the views advanced by M. Roux is the following :—Is osteo-myelitis, or endosteitis, a necessary consequence of every gunshot wound of bones ; and, on its occurrence, does the inflammation necessarily extend throughout the whole medullary system of the bone ? For on the decision in respect to these questions must rest the practice or otherwise of sacrificing the whole bone by disarticulation when surgical interference of some kind is rendered obviously necessary from the protracted results of gunshot injuries. Now these questions were very fully discussed at several meetings of the Imperial Academy of Medicine at Paris in the year 1860, and were more particularly examined in a discourse delivered by Baron Larrey, which he

¹ Detailed reports of these cases will be found in a pamphlet, embodying the memoir on this subject read at the Imperial Academy of Medicine, published by Dr. Jules Roux, and entitled ‘ De l’ostéo-myélite et des amputations secondaires à la suite des coups de feu, d’après des observations recueillies à l’hôpital de la marine de Saint-Maudrier sur les blessés de l’armée d’Italie.’ Paris, 1860, pp. 82.

afterwards published.¹ Without entering into the course of his arguments I will quote the conclusions he arrived at; for they seem to be most consonant with facts, and with the opinions held by the majority of surgeons at the present time. Baron Larrey's conclusions are six in number,² and are as follows:

1st. Osteo-myelitis, after gunshot wounds, is more frequent than has been hitherto supposed, but is not inevitable, and in most instances is a means of cure.

2nd. It may either be limited to a given point of the bone, extend itself partially, or invade the whole of the bone more or less quickly.

3rd. Every rational mode of treatment must be adopted in the first instance. We are encouraged to do so because we know osteo-myelitis is susceptible of spontaneous cure.

4th. Sometimes it necessitates resection, and sometimes consecutive amputation; and sometimes, in certain cases, disarticulation is preferable.

5th. The existence of osteo-myelitis is sufficient to explain the want of success which occasionally follows partial operations in bones affected with this inflammation; but,

6thly. It does not justify the too exclusive proposition in surgery, that resections of joints, and amputations in the shafts of bones, are to be abandoned for disarticulation in all such cases.

When we remember the frequent instances which have occurred where balls have remained impacted in the spongy tissues of bones with impunity, without any evidence, when afterwards examined, of inflammation having been excited; when we remember the cases of gunshot fractures, even of the femur, which become consolidated under proper treatment, we cannot I think help concluding that osteo-myelitis after gunshot wound is not so universal in occurrence as has been argued by M. Roux, but must adopt generally the conclusions expressed by Baron Larrey on the subject.

¹ 'Des Amputations consécutives à l'ostéo-myélite, dans les fractures des membres par armes à feu.' Par M. H. Baron Larrey, Paris, Baillière et fils. 1860.

² Op. cit., p. 26.

I now wish to try and carry the settlement of the question of the treatment of chronic osteo-myelitis a step further in precision, especially in cases where want of success has seemingly followed partial operations from this cause. Many cases come before military surgeons in which, after amputation has been performed in continuity for gunshot injuries, or for the effects of osteo-myelitis consequent upon them, the portions of the limbs left subsequently present such diseased conditions as to necessitate further surgical interference in order to avert fatal consequences from the patients. In these cases, where the morbid state of all the tissues is manifestly due to the continued osteo-myelitic action subsequent to the amputation, what is the course to be pursued? The arguments of M. Jules Roux would urge most forcibly in these cases that ex-articulation is the only treatment that can scientifically be adopted, and even according to the views propounded in the conclusions of Baron Larrey, these would appear to be the certain cases to which he refers in his fourth conclusion, where curative treatment in the first place, and consecutive amputation in the next place, having failed, disarticulation would be held to be the preferable course to follow. I have been led to adopt a different conclusion, but before giving my reasons I would first ask the attention of the Society to the following four preparations from the museum of the Army Medical Department.

Preparation No. 2918 (Plate II, fig. 1) shows the "upper portion of a humerus affected with necrosis after amputation at the middle of the arm in consequence of compound gunshot fracture. The patient, private J. Seaman, 1st Battalion Coldstream Guards, was wounded at Inkerman on November 5th, 1854. The primary amputation was performed in the Crimea. Secondary amputation at the shoulder was performed in England on July the 25th, 1855, by Dr. Bowen, Assistant-Surgeon, Coldstream Guards."

Osteophytic growth surrounds two thirds of the circumference of the sequestrum; it is limited to the parts exterior to the capsular ligament. The head and neck of the bone within the capsular ligament are in a state of osteo-porosis.

Preparation No. 2919 (Plate I, fig. 2) exhibits "Necrosis of the upper portion of the humerus of the right arm after amputation at the middle of the bone in consequence of compound gunshot fracture of the bones of the forearm."

"The patient, James Curds, 1st Battalion Coldstream Guards, was wounded at Inkerman, on the 5th of November, 1854. The first amputation was performed in the Crimea. The second amputation at the shoulder-joint was performed in England by Dr. Monroe, Surgeon-Major, Coldstream Guards, on the 25th of July, 1855."

This specimen differs in some respects from the last. The sequestrum extends rather higher up, and terminates by a conical apex, the top of which rises to a level with the smaller tubercle of the bone. The osteophytic growth below is more extensive and extends rather higher. At the end of the stump it is thickly developed, leaving only a small central opening, through which a small portion only of the necrosed bone can be seen. Its condition indicates that a portion of the dead shaft had at some time in the course of treatment been removed from the end of the stump. The head of the bone is in a state of osteo-porosis.

Specimen No. 2916 (Plate I, fig. 1) is a section of the upper half of a humerus which was exarticulated at the shoulder, as a secondary operation to amputation in continuity, for a gunshot wound. The primary amputation was performed in May, 1855. In September, 1855, the patient, a young man aged 23 years, was admitted into Fort Pitt. The amputation wound was then cicatrized with the exception of two small openings. The patient's general health was indifferent. Subsequently to admission the whole stump was attacked by inflammation, followed by abscesses, which left two sinuous openings near the axilla, as well as general thickening of all the tissues of the stump. On November 11th a ring of dead bone, at the site of the amputation, was removed from the end of the humerus by incision. The patient's general health afterwards improved, but repeated inflammatory attacks occurred in 1856. In the beginning of April of that year an unfavorable action took place, and secondary ampu-

tation was decided upon as affording the only hope of saving life. This was performed on April the 19th. The patient died on May the 1st, 1856, of subacute peritonitis and other symptoms of pyæmia.

Preparation No. 3625 (Plate II, figs. 2 and 3) exhibits the head, neck, and part of the shaft of a right femur, illustrating the effects of endosteitis after a gunshot injury. Amputation was performed in the middle of the thigh soon after the injury.

The portion of the shaft exhibits a copious deposit of new bone, thickened towards the amputated end, and superficially presenting a strongly marked nodulated and laminated character. The osteophytic nodules and laminæ are of various sizes and forms of outline, but nearly all present a direction as if their growth had been from below upwards. In this outer covering of new bone there are four cloacal openings: three small and nearly circular in front, and one irregularly longitudinal, three inches in length, posteriorly.

The trochanters, neck, and head of the bone are free from the osteophytic deposit. They also appear free from taint of endosteitis, but from the absence of usual weight are doubtless to a certain extent affected with porosis.

Within the covering of new bone is a sequestrum of the original shaft, extending from the line of amputation up to an inch, or inch and a half, below the small trochanter.

History of the case taken from the museum records.

Private John Sole, 2nd Battalion Rifle Brigade, aged 24 years, was wounded on the 28th of Nov., 1857, at Cawnpore, by a grapeshot in the right leg. Amputation was performed at the middle of the thigh. (From the situation of the amputation it is to be presumed that the lower part of the femur, or knee-joint, were involved in the original injury, but no description of the wound received in India beyond the above is recorded.)

The patient was admitted into the detachment hospital at Gravesend on the 8th of July, 1858, having arrived with invalids from India by the ship "Argo." He was much emaciated. The stump had never healed, and was reported to have shown

sigus of gangrene on board ship. There were several unhealthy looking sores on the face of the stump along the line of the amputation incision, and from them a profuse purulent discharge escaped.

The patient improved considerably for some time after his arrival at the hospital, gaining flesh and strength, and the sores assumed a more healthy appearance. Great pain was, however, occasionally complained of in the stump.

About the 20th of August, a little more than a month after admission, a swelling of considerable size appeared on the under surface of the stump, which, on being opened, gave issue to a large quantity of purulent discharge. Dead bone was felt through the opening thus formed.

He subsequently again lost flesh and strength, his appetite became bad, he suffered from bed-sores, the discharge from the stump was increased, and on the 11th of September he died.

At the post-mortem examination all the viscera of the chest and abdomen were found to be in a normal condition.

These four cases at first sight tend to support the doctrine laid down by M. Roux, as to the necessity of treatment by exarticulation. In all of them there has been a gunshot wound which has led to the necessity of amputation in the first place, but inflammation of the medullary membrane has advanced so that, ultimately, exarticulation has been resorted to in three of the cases, while in the fourth death occurred without operative interference. In none of them does the periosteal investment appear to have been involved in the inflammatory action beyond that degree of excitement which was serviceable for producing new deposit of bone. There is no reason to suppose that in any one of these cases the amputation was not performed sufficiently high to remove all the structures directly involved in the primary injury; nor is there any ground for supposing that the state of health of the patient, or any peculiarity in the operation itself, induced the subsequent unhealthy condition in the remaining portion of the shaft of the bone. We are left to conclude, then, that the endosteitis was the result of the shock of the original gunshot

injury, that it probably existed throughout the whole shaft of the bone at the time of the amputation, and did not subside afterwards in that portion which was left in the stump.

That endosteitis of such an extent may be set up by the *concussion* of a gunshot wound alone, irrespective of fracture or the effects of amputation, is illustrated by specimen No. $\frac{3}{2} \frac{9}{3} \frac{3}{7} \frac{4}{2}$. This preparation shows us that the entire shaft of the femur has been subjected to the action of endosteitis; yet the musket-ball, which led to this extensive mischief, simply penetrated the soft structures and struck the bone, without producing complete, or even a partial, fracture of its substance. (Plate I, fig. 4.)

But to revert to the practical question before named, viz., whether surgeons are justified by the circumstances of such cases as these in which endosteitis is presented in its most extensive forms, in concluding that exarticulation is the only means of cure.

I next ask your attention to the following cases, for they appear to me to be very instructive in reference to the question under consideration. They are, I believe, examples of cure by other means and with more satisfactory results, under circumstances precisely analogous to those just now referred to, in which the treatment of exarticulation was practised.

CASE 1.—Sergeant H. Pearce, 103rd Regiment, invalided from India, was admitted into hospital at Fort Pitt, during the year 1862, on account of general endosteitis of the upper half of a femur after amputation in its middle third, which, though not the effect of gunshot, presented precisely the same features as if it had resulted from such a violent injury. The whole stump up to the hip presented a thoroughly diseased appearance; the soft parts were tumefied, œdematous, and painful, and were traversed by sinuses leading to dead bone in several directions. The patient's general health was very greatly impaired; he was in a very despondent state of mind; and, according to his own account, had suffered so long and so much that life was a burden to him. This case led to a

good deal of discussion as to its proper treatment. At one time, in consequence of the very unhealthy aspect of the whole stump, and partly influenced by the results of the experience of M. Roux in cases of a similar nature, at a general consultation of the staff of the hospital, exarticulation at the hip-joint was determined upon. Fortunately, however, before this serious operation was undertaken, a study of the museum preparations which have been brought before the notice of the Society, and some others of a similar kind, led me to determine to try as a preliminary measure a simpler operation, leaving the more severe one, if still required, as a last resource.

This consisted in opening the cicatrix of the amputation wound, and removing all pieces of necrosed bone that might be found within the remaining portion of the shaft. There would then be the opportunity of observing whether nature would not be equal to instituting a reparative action, and effecting the necessary contraction and consolidation of any new bone which had been thrown out around the diseased portion of the shaft, when these sources of irritation were removed. Complete success attended this effort. The dead portion of the shaft of the femur which reached up to the trochanters was extracted together with some small detached fragments, and the patient rapidly improved in all respects afterwards. Eventually an artificial limb was applied to the stump and worn without inconvenience, and the patient left the hospital walking with the aid of a stick.

The principal portion of the bone removed is shown in Plate II, fig. 4.

CASE. 2.—A soldier was under the care of Assistant-Surgeon Dr. Becker, then acting as pathologist in the hospital at Scutari, during the Crimean war, in which a sequestrum, six inches in length, formed by nearly the entire circumference of the shaft of the femur, was extracted. The end of the sequestrum had previously protruded from the face of the stump. This morbid condition followed amputation after a gunshot wound, and continued osteo-myelitis in the remain-

ing portion of the bone. The removal of the dead bone was followed by a sound state of the stump in about three weeks.

CASE 3.—Corporal John Roberts, R.A., æt. 17 years, had his left leg completely smashed by a round-shot just above the knee, at Alumbagh, on the relief of Lucknow, on the 25th of September, 1857. The limb was amputated four inches and a half below the trochanter major, a few hours after the injury, by Dr. F. Innes, Surgeon of the 84th Regiment. A fortnight after the operation the healing process was sufficiently advanced to allow of the patient's removal in a dhooley to Cawnpore. He was under hospital treatment for a fortnight at Cawnpore, and was then sent on to Allahabad. He continued improving, and six weeks after his arrival at this last-named station the amputation incision of the stump closed completely. The cicatrix was not, however, firm on pressure, and a short time after having thus apparently become healed, a small opening appeared in it, through which there gradually became protruded about an inch of bare bone, comprising the whole circumference of the femur. This was moved backwards and forwards every morning, the movement causing considerable pain towards the hip-joint, and within a fortnight from its first appearance the sequestrum was sufficiently loosened to admit of extraction. It was three inches and a half in length; smooth at the amputated end for about an inch, but roughened on the surface for the remaining two and a half inches; and terminated in three sharply pointed spiculæ. The stump then became firmly cicatrized.

A careful examination of this patient was made in October, 1862, five years after the amputation. He was at this date employed in the arsenal at Woolwich, his work lasting ten hours a day, and his duty being to stoop and put in their places fusees after having carried them some distance. The following is the description of the condition of the stump at this time :—"The present bony formation of the stump is of the same length from the trochanter major as the original upper half of the amputated femur. The extremity of the

new bone appears hard and firm, but is at least double the size in all directions of the original bone. The integument of the stump is quite sound, and there is no pain felt in it except on change of weather; but occasionally the new skin feels tight as if the new bone were too large for it. The flap appears well developed although the muscular portion of it does not entirely cover the bone. The amount of strength and endurance of pressure in the stump is very considerable; with a light artificial leg he has walked fourteen miles without difficulty. He generally, however, wears a heavy wooden leg while at his work. There is perfect motion of the hip-joint.

The result of the cases I have just named where stumps have been preserved without exarticulation or further amputation; and a careful examination of the diseased conditions in the preparations I have brought before the Society, where stumps have been removed by exarticulation, or where death has occurred, as in the case from which the preparation of the femur was taken, without operative interference; have led me to the conclusion that in all cases, however severe, of endosteitis and endosteitic necrosis after gunshot injuries, before resorting to the extreme measure of exarticulation as urged for all cases by M. Jules Roux, and recommended in certain cases by Baron Larrey, the opportunity of effecting a cure by careful and complete removal of sequestra should invariably be tried. The judgment of the surgeon will be tested in determining the precise period when the process of sequestration is sufficiently advanced to admit of operative interference with advantage; and his qualities as a physician will be put to the test in the support he must afford to the patient's constitution while subjected to the irritation inseparable from this protracted ordeal. But when the period has arrived of nearly complete sequestration of the dead bone, then the stump should be opened if amputation has been previously performed; or the steps taken such as are employed in ordinary necrosis if no amputation has been performed; and the necrosed portions be entirely removed, and the case treated on general principles. I now feel certain that if this treatment had been practised instead of exarticula-

tion in the following case represented by preparation No. 2418 (Plate I, fig. 3), on which I myself operated, the stump might have been saved and a cure effected without exarticulation. On examination it will be found that this preparation exhibits a condition which exactly corresponds with the condition of the preceding specimens, though it did not result from an injury by gunshot. The patient, Private Noah Gowan, of the 77th Regiment, injured his wrist in India by a fall, on the 25th of December, 1860. Amputation of the forearm had to be performed on the 9th of January, 1861. Unhealthy action followed, accumulations of pus took place in the arm and elbow-joint, and amputation was again performed in India about three weeks afterwards in the middle of the upper arm. He arrived from India at Fort Pitt on the 25th of April, 1862. The remaining portion of the humerus being then in the necrosed state exhibited in the preparation was removed by exarticulation on the 16th of May following. He was discharged with the parts soundly cicatrized on the 23rd of July.

I have no doubt also that a similar mode of proceeding might have saved the stumps to which the other preparations brought before the Society belonged. In the cases represented by preparation No. 3625 (Plate II, figs. 2 and 3), and by specimen No. $\frac{2}{3}\frac{2}{3}\frac{3}{4}$ (Plate I, figs. 4 and 5), removed post-mortem, not only the limbs but perhaps the lives of the patients might have been preserved by the removal of the bone sequestra, and the arrest and cessation of the irritation caused by their lodgement. The removal of sequestra under such circumstances presents no greater difficulties than they do in cases of necrosis from ordinary causes; in the instances of stumps, their removal, indeed, must ordinarily be an exceedingly easy operation.

It is not a matter of such great importance to avoid exarticulation of a humeral stump as it is of a femoral stump; for the one is almost without danger to life, while in the other life must always be seriously endangered. But even a humeral stump, if the power of the pectoral, latissimus dorsi, and other muscles employed in approximating it to the side,

has not been lost, is often of great value to the possessor. And independent of the dangers of a hip-joint amputation, though these are lessened when practised as a secondary operation, the important use of a thigh-stump for adapting and securing the mechanical contrivances employed to sustain the weight of the body, and to assist in progression, cannot be over-estimated.¹ Any surgical means, therefore, by which such portions of the extremities can be saved are well worthy of study on the part of the surgeon, and as far as the patients themselves are concerned, any ordinary expenditure of time and endurance will be well repaid if a successful issue be obtained eventually.

There is one condition often allied with these cases of protracted endosteitis which might make a surgeon hesitate to trust to such an operation as I have described for his patient's safety and cure. If the articular head of the bone in each of the cases I have brought to the notice of the Society be examined, it will be found that it yields more readily than natural to the pressure of the finger. The cartilaginous surface seems to have lost its own strength and to have lost support beneath; it can readily be bent inwards. The weight of the bone is considerably diminished, and on section it is found that there really is a very considerable absorption of the earthy portion of the structure, and that it has an abnormally cellular appearance; in short, that it is in that condition to which the name of *Osteo-porosis* has been given.

I believe, however, that this condition will not interfere with a successful result in those cases where the necrosed sequestra have been completely removed. We have not the

¹ In the 'Edinburgh Medical Journal' of this month, November, 1864, is reported a successful case of exarticulation at the hip-joint, however, in which the patient, a native of India, does not appear to suffer much from the loss of a thigh-stump. "He uses crutches and gets over the ground rapidly, and goes to work regularly as a tailor." The exarticulation was performed by Professor Fayrer, of the Medical College Hospital, at Calcutta, for osteo-myelitis, following amputation of the thigh at the lower third, rendered necessary by injury to the knee-joint from the kick of a horse.

means of affording demonstrative proof of the existence of the condition above stated in those cases in which success follows the modified operation. I have not the least doubt that the head and neck of the femur, in the instance of Sergeant Pearce, from having been so long unused, and from having been subjected to the irritating effects of the endosteitic inflammation in the neighbouring shaft for nineteen months after the operation of amputation, were in a state of osteo-porosis at the time the sequestra were removed; but that this condition was subsequently repaired when the sources of irritation were taken away. And in proportion as such a stump is employed in its movements with an artificial limb, and thus becomes subjected to the stimulus of use, there can be no doubt that a more and more healthy condition of the bone is gradually obtained.

The year before last I removed a foot in a scrofulous boy, for extensive caries of the ankle-joint, and, on sawing off the two malleoli, I observed that the extremities of both the tibia and fibula were extensively affected with fatty osteo-porosis. The bone was quite soft, honeycombed, and oily fat-cells were visibly occupying the hollow spaces in the porous extremities; yet this stump healed, and subsequently bore the weight of the body and admitted of progression without inconvenience. Here, doubtless, the cancellated tissue gradually recovered a healthy condition and the ends of the bones became firm, by the deposit of new bone, under an improved condition of general health, and the removal of the source of irritation which had previously existed in their immediate neighbourhood.

In conclusion, I would observe that while adopting generally the views of Baron Larrey in reference to the nature, progress, and treatment of osteo-myelitis after gunshot injuries before quoted, the following appear to me to be fair deductions from the facts and observations which have been noticed in this paper.

1st.—In gunshot injuries of bone it will be found for the most part what might be anticipated from the intimate con-

nection which exists between the periosteal and endosteal investments of the bony tissues, and from the violent general mischief effected by the stroke or passage through them of a projectile—that all the structures participate not only in the immediate local destruction, but also in the extended inflammation which follows, whether the inflammation after a time subsides and terminates in repair, or whether it continues in a chronic form.

2nd.—There exists this difference between the inflammation of the endosteum and that of the periosteum; that of the endosteum has a special tendency after gunshot injuries to degenerate into a chronic condition analogous to that of suppuration in other tissues to extend itself along the cancellated structure, and thus to produce disintegration and death of the bony substance; that of the periosteum, at the same time, will exist only to such a degree as to cause it to exert a protective influence by the formation of new bone around the diseased tissues, just as in ordinary cases of necrosis from other causes.

3rd.—If amputation in continuity be performed while the endosteum is suffering from the inflammatory irritation excited by the violent injury to which the whole bone has been subjected, especially when this has assumed a chronic form, the endosteitis will most probably still pursue its course, even though the divided soft parts may at first become healed, slowly inducing death, more or less extensive, of bony tissue, and in time the usual consequences of such a condition throughout the whole stump.

4th.—The morbid condition of the endosteum does not usually extend from the shafts of bones into their apophyses.

5th.—When amputation has been followed by these consequences, exarticulation should not in any case be resorted to for the removal of the diseased stump, until the effect of complete removal of every particle of the dead bone by proper surgical measures has been ascertained.

6th.—Experience shows that although a patient's constitution may be greatly impaired by the prolonged local diseased action to which it has been subjected, and though

there may be every reason to conclude that the articular extremity of the bone is in the condition understood by the term "osteo-porosis," yet the complete removal of the endosteitic sequestra may speedily be followed by restoration of the general health, and by a condition of the stump so sound and firm that it may be applied to any purpose of utility for which it may be competent, according to its length and position.

DESCRIPTION OF PLATE I.

FIG. 1.—Upper portion of humerus affected with endosteitic necrosis. Head and neck of bone in a state of osteo-porosis (the principal sequestrum is represented rather lower than natural).

FIG. 2.—Ditto, ditto. (The outer casing of the new bone has been accidentally broken across at *a*.)

FIG. 3.—Upper portion of a humerus exarticulated for endosteitic necrosis, after amputation for injury by a fall, in India. The necrosis does not extend into the tuberosities, neck, or head of the bone. These parts are, however, in a state of osteo-porosis.

FIG. 4.—A femur with its entire shaft in a state of endosteitic necrosis, consequent on concussion from the stroke of a musket-ball; anterior view. No fracture produced by the projectile. The sequestra, which are visible through the cloacæ, are limited by the apophyses of the bone; *x* and *y* show the limits of the necrosed bone within the shaft.

FIG. 5.—Ditto, ditto. Posterior view. The sequestrum partially visible at *a* does not extend into either trochanter or into the neck of the bone.

Fig. 1.
(N^o 2518.)

G.H.Ford.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

W.West imp

DESCRIPTION OF PLATE II.

FIG. 1.—Section of the upper half of a humerus, exarticulated at the shoulder for the effects of endosteitis after amputation in the middle third, for a gunshot wound. *a* points to the unremoved portion of sequestrum; *b* points to a small sinus; *c* points to the articulating head and neck of bone unpenetrated by the necrosing action. Near *a* on an aspect not shown in the plate was a large cloaca and sinus.

FIG. 2.—Head, neck, and part of the shaft of a femur, illustrating the effects of endosteitis after amputation for gunshot injury: anterior view. The necrosed sequestra partially seen through cloacæ at *a* and *b* do not extend higher than the shaft.

FIG. 3.—Ditto, ditto. Posterior view. The sequestrum partially seen at *a* ceased just below the smaller trochanter. The head, neck, and trochanters are lighter than normal, probably in a state of osteoporosis.

FIG. 4.—Sequestrum removed from the thigh-stump of Sergeant Pearce, July 3rd, 1862 (see abstract of case, p. 54).

- A. Side view (length of natural size, five inches).
- B. End view.

C.H. Ford.

Fig. 2.

Fig. 3.

Fig. 4.
W. West imp.