

**On necrosis : being an experimental inquiry into the agency ascribed to the absorbents, in the removal of the sequestrum : with some observations concerning the adhesion of living to dead bone / by George Gulliver.**

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ON

# NECROSIS:

BEING AN EXPERIMENTAL INQUIRY

INTO THE

AGENCY ASCRIBED TO THE ABSORBENTS,

IN THE

REMOVAL OF THE SEQUESTRUM.

WITH SOME OBSERVATIONS

CONCERNING

THE ADHESION OF LIVING TO DEAD BONE.

BY GEORGE GULLIVER, Esq.,

ASSISTANT-SURGEON, ROYAL HORSE GUARDS.

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FROM THE TWENTY-FIRST VOLUME OF THE MEDICO-CHIRURGICAL  
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NEW YORK

BEING A PRACTICAL INQUIRY

INTO THE

CAUSE OF THE DEATH OF THE PERSONS

WHO

REMOVED OF THE REQUEST

WITH SOME OBSERVATIONS

ON THE

THE ADMISSION OF LIVES TO DEAD BODIES

BY GEORGE GULLIVER, Esq.

OF THE CITY OF NEW YORK.

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COMMUNICATED BY  
SIR JAMES M'GRIGOR, BART., F.R.S.

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READ NOVEMBER 8TH, 1836.

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PERHAPS there is no subject in surgical pathology which has been more diligently investigated than that of necrosis. Independently of its practical importance, the phenomena connected with the death and separation of the old bone, and the admirable resources of nature in the formation of a new one, must ever be regarded with great interest.

It is not therefore surprising that numerous theories have been offered in explanation of this disease; but those who have examined these must have perceived how widely they differ from each other, and that many of the facts adduced are of a no less contradictory nature.



Hence I have undertaken an experimental inquiry into the subject, and without attempting a theory of necrosis, have endeavoured to determine, in the first place, what becomes of the dead bone, and secondly, the means by which it is replaced. In the prosecution of this object I have principally employed dogs and rabbits, and although I am aware that observations made on the lower animals are not always applicable to the physiology of man, it will probably be allowed that the points at issue are susceptible of illustration by experiment.

In the present paper I propose only to relate some observations and experiments instituted with a view to the examination of the first question, namely, whether dead bone admits of removal by absorption; reserving the consideration of the other means by which it may be discharged for a future occasion.

While engaged in the formation of the catalogue of the museum of the Army Medical Department at Chatham in 1829, I was led, from the examination of numerous specimens of necrosis in that collection, to entertain a suspicion that the doctrine of the absorption of dead bone, so confidently asserted in the schools as an ascertained fact, might notwithstanding be founded in error,—and a further attention to the subject tended to confirm this persuasion. As far as I could judge from my own observations, it did not appear necessary to attribute the form and appearance of the dead bone to the agency of the absorbents after it had ceased to be a part of the living body, the facts appearing susceptible of explanation



otherwise; while many cases presented phenomena altogether at variance with the received opinion. I soon learned that Mr. Liston and Mr. Syme, who possessed unusual opportunities for observation, had formed a similar view of the subject, while another great authority, Mr. Stanley, had arrived at a directly contrary conclusion: and Mr. Key, in a communication, recently printed in the Transactions of this Society, has minutely described the absorption of dead bone, in order to illustrate the process of ulceration in articular cartilage.

I have no opportunity of consulting the numerous original works which have appeared at different times concerning necrosis, but it is unnecessary in this place to exemplify the extent to which the doctrine of the absorption of dead bone has been believed and promulgated, since it is generally taught in the schools of London, and an enumeration of those who have adopted it would comprehend almost every writer of eminence on the subject. Dr. Thomson, indeed, although admitting the power of granulations in absorbing dead bone, considers the subject deserving of further inquiry; and Dr. Craigie simply attributes the removal of the old bone to its separation through the new osseous cylinder.

The facts which are brought forward in proof of the absorption of dead bone are simple enough, and easily enumerated; to wit, the gradual disappearance of the sequestrum in many cases of alleged necrosis; the irregular and eroded state of the dead portion; the contact of granulations with the indentations on its



surface; the absorption of the fang of a transplanted tooth; and finally, it has been stated, I believe either on the authority of Mr. Abernethy or Sir William Blizard, that portions of dead bone had diminished in weight after having been kept in contact with the granulations of an ulcer\*.

The explanation deduced from all these circumstances would appear irresistible if we inquired no further, but there are facts which must have been observed by almost every practical surgeon altogether at variance with this theory. It appears indeed somewhat extraordinary that Wiedmann, F. Ribes, and Jules Cloquet, never doubted the agency of the absorbents in the removal of dead bone, although they had each observed examples in which it had been incarcerated for years, without apparent diminution, in a new osseous cylinder, from the internal surface of which more or less purulent matter was secreted. Mr. Liston adduces cases of detached pieces of bone in similar circumstances long remaining unaltered in form, in some of which amputation of the limb was required from the irritation of a dead portion so small, that it is inconceivable how it could have re-

\* In Mr. Palmer's edition of the works of John Hunter, the following note appears. "Portions of dead bone were often observed to be entirely absorbed in cases of necrosis; and in some experiments made by Mr. Thomas Blizard, in which disks of bone were bound on over ulcers, the surfaces of these disks were found to be eaten out, or destroyed, just as in common caries." Vol. I. p. 255. The result of my experiments justifies the belief that there must be some mistake in this statement.



sisted absorption, if that were the process employed by nature for the removal of dead bone; and Mr. Syme mentions similar instances.

But if the sequestrum is not absorbed, what becomes of it? It may be remarked, in the first place, that they are not all cases of necrosis that have been so denominated. Under this head, in the museums of anatomy, a class of specimens is sometimes presented to our notice which seem to me to admit of an explanation differing from that commonly assigned to them. These are generally the shafts of the long bones, prodigiously thickened and irregularly perforated with holes for the transmission of blood vessels, or by cloacæ leading to the cavities of abscesses, and sometimes singularly crooked and mis-shapen, as if at one period of the disease they had been softened, and influenced by mechanical force. In the centre of such bones a very small portion is sometimes found dead and detached, but more frequently the shaft is simply very thick and dense throughout. The former have frequently been regarded as examples in which the absorption is nearly effected; the latter as the completion of this process. It is probable that both are instances of long continued inflammation of bone, the first attended with death and separation of a small central fragment, which had afterwards undergone no alteration of form, and that the second was never at any period a case of necrosis.

The deposition of a cylinder of new bone around the old one, is not an absolute proof of the death of the latter, as I have had frequent opportunities of



ascertaining in the course of my experiments. Nature often exhibits a prospective contrivance in the formation of a new osseous shell, or in the enlargement of a part of the old shaft, before actual necrosis has taken place; a fact which has not escaped the observation of Mr. Russell and Dr. Macartney. In the museum of St. Bartholomew's hospital, there is the tibia of a dog incased in a shell of new bone, and partly detached, but the injection has run pretty freely into the old bone \*. In such instances, the part which has suffered the most intense inflammation may become partially eroded, and gradually removed by absorption, if it retain its vitality long enough, while a deposition of new osseous matter gradually supplies the loss, death of the old bone having formed no part of the phenomena. This is probably the explanation of many cases of alleged absorption of dead bone. But if a piece of bone truly dead, be inclosed within a new osseous cylinder, then it is indeed a bad case of necrosis, which the patient will carry to the grave with him, unless relieved of the sequestrum otherwise than by absorption.

The worm-eaten appearance on the surface of many sequestra may be explicable in two ways. The most numerous examples of this kind are those of necrosis of the inner layer of the shaft of the long bones, with thickening of the outer portion,—a form

\* It is proper to notice that Mr. Stanley considers this to be doubtful. The preparation will be found under the head of "Bone," No. 10.



of disease known to Bordenave, Haller, <sup>Collison</sup> ~~Collison~~, and Tenon; and since more fully explained by Brun, Brugnoli, Penchianati, Dr. Knox, Mr. Syme, and others. In such cases, irregular death, and separation of a portion of a bone, may be expected to produce an equally irregular surface: the part would not necessarily die in a determinate form, any more than in cases of sloughing of soft textures; and when the outer layer of an entire cylinder of necrosed bone presents erosions on its surface, it seems more reasonable to refer these to the effect of the ulcerative process, while the part retained its vitality, than to the action of the absorbents after its death.

The aspect and situation of the granulations is equally inconclusive. They are seen to be extremely vascular, and accurately corresponding to the indentations on the under surface of a superficial layer of dead bone in progress of exfoliation, a case in which it has not often been supposed that the dead portion suffers diminution from the absorbents, the action of which is confined to the surface of the living bone in immediate contact with that about to be separated. The vascular structure adjusted to the superficial excavations on the surface of the sequestrum, is what might be expected from the work of exfoliation in some instances, or from the extension of the ossific process into the vacant spaces in others.

I am not aware that the absorption of the fang of a transplanted tooth is a well authenticated fact; but if so, it would seem to indicate that the tooth, having preserved its vitality, had become a part of the living



body to which it was attached, and accordingly subject to its laws.

With regard to the diminution said to have taken place in portions of dead bone kept in contact with the granulations of an ulcer, we require more precise information. It will be seen that the statement is altogether at variance with the result of my experiments. Dr. Davy has suggested to me, that if dead bone be subjected to the combined action of air, heat, and moisture, it might lose weight from the decomposition of its animal part, especially if the discharge were long confined; and the comparative lightness of bones in which the putrefactive fermentation has proceeded favourably, must be familiar to those who have observed the maceration of skeletons.

I proceed to the narration of some cases and experiments by which I have been led to the opinions expressed in this paper. The results of many of the experiments are preserved in the museum of the Army Medical Department, which is open to the profession through the kindness of the Director-General.

#### *CASE I.*

A man suffered amputation of the thigh, and the bone was covered in the usual manner by the soft parts. Profuse suppuration ensued, and the patient died four months after the operation, exhausted by hectic fever and diarrhœa.

The entire circumference of the extremity of the thigh bone was found to be dead, and partly sepa-



rated from the living bone, but the surface on which the saw had acted was precisely in the same condition as when first divided. (Loc. D. 4. No. 28, in the Museum of the Army Medical Department.)

#### *CASE II.*

A boy, aged 17, was the subject of necrosis involving the whole internal circumference of the shaft of the humerus. A small part of the sequestrum protruded and was removed by the cutting pliers, but the remaining greater portion was so firmly incarcerated that it was not extracted until four months subsequently, during which time it was imbedded in the soft textures. The edges of a cut, which had been made in the sequestrum at the time of the operation, and which may be seen in the upper part of the preparation, had undergone no change whatever. The patient recovered. (C. 6, in Mr. Liston's collection.)

#### *CASE III.*

A patient had ankylosis of the metacarpal bone with the proximal phalanx of the great toe. The articular extremities became necrosed, and several small sequestra were discharged, the disease having continued twenty-four years. The metacarpal bone was divided near its base with the cutting pliers, and the diseased bones removed; and the base was subsequently excised to secure the anterior tibial artery. A blackened sequestrum, about the size of a horse-bean, was found in a cavity in the situation of the



articulation of the phalanx with the metacarpal bone, where it had probably been inclosed for a series of years. (F. 1, in Mr. Liston's museum.)

*CASE IV.*

A female, aged 50, had a collection of pus on the fore part of the thigh, communicating with the knee-joint. The abscess opened, profuse discharge occurred, and the patient was reduced by hectic fever, when the limb was removed, and she completely recovered.

The lower third of the femur was enlarged and irregular on the surface. In its anterior part was a small cloaca with smooth edges, through which might be seen a minute sequestrum of the cancellated structure, which had probably been so situated for upwards of two years. (C. 22, in Mr. Liston's collection.)

*CASE V.*

Miss M——, aged 20, had necrosis of the proximal phalanx of the great toe. The dead portion was ascertained to be loose, and an attempt was made to remove it by the assistance of a small screw. Twelve months afterwards, there being reason to suppose that the joint was implicated, the member was amputated. The sequestrum, about the size of a horse-bean, was found to involve a part of the articular surface; and it was loosely confined in a cavity, but in such a manner that extraction could not have been easily effected. (C. 65, in Mr. Liston's collection.)



*EXPERIMENT I.*

A thin portion of the surface of the shaft of a human tibia was kept in contact for seventeen days with a large ulcer studded with granulations, in a man's leg. The bone having been removed, dried, and weighed, was found to have undergone no alteration either in weight or appearance.

*EXPERIMENT II.*

A section of the internal circumference of the shaft of the human tibia, weighing 8.9 grains, was introduced into a seton at the back of a man's neck, and allowed to remain there thirty-two days, during which time the suppuration was very scanty. On examination of the bone, it was found to have undergone no change whatever, either in weight or appearance.

*EXPERIMENT III.*

A thin portion of the external part of the human fibula, from near the upper extremity of the bone, weighing 6.7 grains, was put into a seton at the back of a man's neck, and kept there twenty-nine days. The suppuration was very scanty. The bone presented no alteration either in weight or appearance.

*EXPERIMENT IV.*

A section of the shaft of the human humerus, weighing 10.7 grains, and comprehending the en-



tire thickness of the bone, was introduced into a seton at the back of a man's neck, and retained there sixty-five days. The suppuration was at first scanty, but became copious during the latter five weeks. The bone was removed, and found to have undergone no alteration in appearance, but it had increased exactly one tenth of a grain in weight, probably from some albuminous matter which was not entirely dissipated by drying.

#### EXPERIMENT V.

A portion of a man's fibula was kept deeply imbedded for five weeks in the soft parts of a dog's leg. There was rather copious suppuration. On examination after the part had been injected, the bone was found unchanged, and the cavity in which it was contained was shewn to be very vascular. (C. 66, in Mr. Liston's collection.)

#### EXPERIMENT VI.

A portion of the shaft of a dog's thigh bone, weighing 7.8 grains, was introduced deeply between the muscles and periosteum of another dog's leg, and kept there two months. Suppuration was soon established, and continued till the animal was killed. The bone had suffered no alteration whatever. The cavity in which it had lain was very vascular, being made deeply red by injection with size and vermilion.

#### EXPERIMENT VII.

A portion of the shaft of the human tibia, weigh-



ing 9.8 grains, was introduced into the subcutaneous cellular substance of a dog's leg, and allowed to remain there three months. The wound soon healed, and continued well for nearly two months, when a small ulcerated aperture formed in the cicatrix, in consequence of the bone having been moved about roughly, and suppuration ensued. The bone was found to have undergone no alteration whatever.

#### *EXPERIMENT VIII.*

A thin portion of the shaft of the human humerus was placed in the subcutaneous cellular tissue of a dog's leg, and allowed to remain there four months. The wound soon healed, and continued sound till the animal was killed. The bone had suffered no change whatever: it adhered slightly to the cellular substance, so as to stretch out the filaments of the latter as the bone was pulled away.

#### *EXPERIMENT IX.*

A piece of the metacarpal bone of a rabbit was introduced into the medullary canal of the tibia of another rabbit, where it remained seven weeks. The wound readily healed, and the animal continued healthy and active until it was killed.

The foreign bone, which I had not weighed previously to the experiment, had undergone no appreciable change: it was imbedded in a soft substance, which I have shewn to be highly vascular by injection. The tibia was simply thickened. (E. P. B.



34 and 54, in the museum of the Army Medical Department.)

*EXPERIMENT X.*

The fibula of a rabbit was introduced into the medullary canal of the tibia of another rabbit, where it was kept thirty-six days. I omitted to weigh the fibula. It had undergone no appreciable diminution, but a portion of new bone was adherent to its surface. The tibia was enlarged by osseous deposit, both on its outer and inner surfaces, and the foreign bone had become firmly locked in the centre of the new bone. (E. P. B. 50, in the museum of the Army Medical Department.)

*EXPERIMENT XI.*

A portion of the shaft of a rabbit's tibia, weighing 2.1 grains, was put into the medullary canal of the tibia of another rabbit, and retained there thirty-four days.

The foreign bone was found to have undergone no change: it was surrounded by highly vascular lymph, and there was a large cyst, which had not yet burst, containing a white, concrete, purulent matter, and communicating with the cavity of the tibia. (E. P. B. 35 and 36, in the museum of the Army Medical Department.)

*EXPERIMENT XII.*

A piece of the shaft of a rabbit's tibia, weighing 1.5 grain, and a bit of the spongy extremity of the



same bone, weighing one grain, were kept in the medullary cavity of another rabbit's tibia for twenty-five days. The weights were marked on these portions of bone with a black lead pencil.

On being removed and dried, the first portion was found unchanged, and the second had increased one tenth of a grain in weight, probably from matter which had not been dissipated in drying. The pencil marks were not obliterated.

There was much inflammation of the limb, and pus with vascular lymph surrounded the adventitious portions of bone. (E. P. B. 48 and 49, in the museum of the Army Medical Department.)

#### EXPERIMENT XIII.

A section of the shaft of the human tibia, weighing 3.8 grains, was introduced into the medullary canal of a rabbit's tibia, and kept there till the animal was killed, twenty-five days after the operation. The limb was removed and macerated three months, when the bit of bone was ascertained to have undergone no alteration. There was no suppuration. (E. P. B. 55, in the museum of the Army Medical Department.)

#### EXPERIMENT XIV.

A portion of the shaft of a rabbit's tibia, weighing 1.5 grain, was introduced into the medullary canal of the left tibia of another rabbit, and twenty days subsequently a similar piece, weighing 1.7 grain, was put into the tube of the right tibia. The



animal was killed seven weeks after the first operation, and the limbs were macerated four months.

The adventitious pieces of bone had undergone no change, and the tibia presented no disease. The animal had grown considerably, and had been throughout active and healthy, excepting three or four days after each experiment. (E. P. B. 59, in the museum of the Army Medical Department.)

#### EXPERIMENT XV.

A bit of the shaft of a rabbit's tibia, weighing 2.2 grains was introduced into the tube of another rabbit's tibia, and kept there seven weeks. The wound healed in the course of a few days.

The adventitious bone weighed 2.37 grains, and it was firmly imbedded in the medullary canal. The increase of weight was accounted for by two well defined specks of new osseous matter deposited on its surface; and these deposits were removed and analysed by Dr. Davy, who found their composition to be that of true bone. (E. P. B. 57 and 58, in the museum of the Army Medical Department.)

#### EXPERIMENT XVI.

A portion of the shaft of the human tibia was weighed, and introduced into the tube of a rabbit's tibia, seven weeks after which the animal was killed.

The limb was macerated three months during the summer, when a part of the circumference of the tibia being removed to expose the foreign bone, it was



found firmly adherent to the inner surface of the rabbit's tibia, and the union was effected by true osseous substance, as proved by the analysis of Dr. Davy. (E. P. B. 56, in the museum of the Army Medical Department.)

*EXPERIMENT XVII.*

A portion of the human tibia was introduced into the tibia of a rabbit about half grown. The animal continued active and healthy, and grew to the adult size. It was killed fourteen weeks after the operation, when the foreign bone was found to be firmly agglutinated to the rabbit's tibia, by new osseous matter. (C. 57, in Mr. Liston's collection.)

*EXPERIMENT XVIII.*

A portion of a rabbit's tibia, weighing 1.1 grain, having been made to exfoliate by cauterization, was introduced into the medullary canal of the other tibia of the same animal.

After remaining there forty-two days, it was found to have undergone no alteration.

*EXPERIMENT XIX.*

A splint of a man's bone was introduced into the medullary canal of a rabbit's tibia. The animal became healthy and playful after the operation, and was kept as a pet in the house, for upwards of fifteen months, until it died. The inclosed bone was found to have suffered no change; it was separated from



the tibia, which was somewhat thickened, by boiling. (C. 58, in Mr. Liston's collection.)

These experiments are selected from a great number which I have made, all tending to the same conclusion. They have not been sufficiently varied and extensive to admit of being adduced as peremptory proof of the impossibility of the absorption of dead bone, in opposition to the incontestable power of the absorbents in the removal of inorganic particles from the living body; but I conceive that it is now fully established, with how much difficulty dead bone is subject to absorption, and that whatever may be the agency of this process in the removal of living parts, it can no longer be regarded as the means by which the sequestrum disappears in cases of necrosis.

The result of the inquiry is not altogether devoid of interest in relation to some important physiological questions. The occasional persistence of bullets in the living body has been usually ascribed to the slight irritation produced by them in the contiguous tissues. But the consolidation by osseous substance, of dead with living bone, is a curious fact in the history of adhesion, which may tend to illustrate the nature of the union between the vascular and extra vascular parts of animals, and to shew that the opinion of Mr. Hunter concerning the vitality of transplanted parts is not without exception.

It appears to me to be a very interesting fact, that a tissue which has been long dead should possess the

power of attracting, as it were, particles similar to itself from the blood. To complete the resemblance to assimilation, we have only to suppose the dead matter to be porous, and the new particles attracted to its interstices. And if new bone can be deposited by the neighbouring living textures on a dead substance, and become firmly adherent to it, as shewn in the experiments 10, 15, 16, and 17, we may be permitted to doubt the conclusions of those physiologists who adopt the views of Haller and Dethlef concerning the reparation of injured bones, since the close connection of the new to the surface of the old bone, is no proof that the former was secreted by the vessels of the latter, however necessary in human subjects the presence of the old bone may be to the establishment and continuance of the ossific process.

But as I propose to institute further experiments concerning this subject, it may be proper to defer its consideration for a future occasion.



