OBSERVATIONS ON INJURIES OF THE BONES OF THE LIMBS BY THE S. BULLET.

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Injuries inflicted on bones by the S. bullet (Spitzgeschoss) vary enormously and may be classified. All bullet fractures are compound.

1. A bullet grazing a long bone may produce a transverse fracture.—I have seen an example in the humerus and in the tibia; a thin crack across the middle of the shaft without displacement. The skin wounds healed quickly and the broken bones united firmly. Writers on military surgery describe this kind of fracture as rare.

2. A bullet may completely pierce the shaft of a bone.—There are usually some fragments of bone at the aperture of exit. Perforation of a long bone by a bullet without fracture is an uncommon effect in the middle of a bone, but not in the cancellous tissue of the lower end of the femur and the upper part of the tibia. I have seen three cases, one in the femur and two in the tibia. The example in the femur was caused by a shrapnel bullet (fig. 1).

3. The bullet may embed itself in the bone with only slight damage.—The condyloid end of the femur is the favourite place for such an occurrence. I have seen four examples, two being under my care: in two the bullet entered base foremost (figs. 2 and 3).

In discussing the embedding of bullets in bone reliance cannot absolutely be placed on radiograms. A bullet may appear to be embedded in bone, but when the surgeon attempts to remove it the bullet will be found in tissues not even in contact with the bone. In the “Report on the Surgical Cases in the South African War, 1899-1902” there is a radiogram showing a Mauser bullet in the tibia just above the inferior articular facet. It is stated on p. 274 of the Report, that the bullet “entered above the patella while the knee was flexed to a right angle, passed through the head of the tibia, and into its medullary canal, finally lodging just above the ankle-joint. The tibia was fractured at its narrowest part, but the bullet caused no trouble and was not removed.” It is a fair comment on this case that there is no proof that this bullet lies within the medullary cavity, or in the substance of the tibia.
(4) *A bullet strikes the shaft of a long bone, breaks and comminutes it.*—This is a common variety of gunshot injury. The bullet may traverse the shaft of the bone and escape from the limb, or it may lie among the broken pieces of bone. The number of fragments varies. When the bullet pierces the shaft of a bone it often produces a stellate or "butterfly" fracture in which four oblique fissures radiate from the bullet tract (fig. 4). The best examples of butterfly fracture I have seen were in the radius, the ulna, the lower part of the humerus, and the middle of the fibula.
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Fig. 2.—A bullet embedded, base foremost, in the femur near the adductor tubercle. (From a radiogram.)

Fig. 3.—The bones of the ankle-joint. A bullet is embedded in the astragalus. It entered the bone from the heel, base foremost, and was extracted through an incision on the dorsum of the foot by Lieutenant J. St. A. Titmas. (This figure is constructed from a radiogram.)
The flattened surfaces of the shafts of these bones seem to favour the production of this variety of fracture. When there is only one wing to this imaginary butterfly it is called a "wedge" fracture. Often one wing of the butterfly is represented by several fragments. Many bullet-fractures of the shafts of large bones are variations of the butterfly pattern.

(5) A bullet strikes a long bone near a joint and breaks the end of the bone into small fragments.—Briefly, the effects of the bullet on long bones may be summarized thus:—

The S. bullet may simply graze the surface of the shaft of a long bone and break it, or traverse the shaft of the bone and leave a clean tunnel, or embed itself in the bone. More frequently it breaks and comminutes the bone, and occasionally, especially at the extremities of long bones, reduces the osseous tissue to fragments. I am interested to ascertain the factors that lead to such variations in the effects produced by this bullet.

The Spitzgeschoss is a short, pointed bullet weighing one hundred and fifty-four grains. It has a solid core of lead enclosed in a ferro-nickel case, or mantle, deficient at the base (fig. 5). The object of the point is to lessen the resistance of the air and the nickel mantle is necessary, lead being too soft to follow the rifling of the barrel. Grooves cut by the rifling can often be seen on bullets removed from wounded men. The pointed end of the S. bullet tends to make it somersault.

The English service bullet, Mark vii, weighs one hundred and seventy-four grains. It has a cupro-nickel mantle and a core of lead. Near the point there is a cone of aluminium commonly called "the jockey" (fig. 6, b); it is required to maintain a correct balance of the bullet when in flight. The aluminium cone is completely covered by the nickel sheath or mantle.
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Nickel-coated bullets may be deformed in various ways by striking hard bodies:—

(a) The nickel mantle is often stripped off and curls up (fig. 5, c).

(b) After stripping; the lead core may remain coherent (fig. 6, a) although irregular in shape.

![Fig. 5.](image)

**Fig. 5.**—(a) A Spitzgeschoss (natural size); it weighs one hundred and fifty-four grains. (b) A Spitzgeschoss in section, showing the lead core and the nickel covering. (c) The nickel covering stripped from the bullet and twisted by impact against a hard body, such as a stone.

![Fig. 6.](image)

**Fig. 6.**—(a) The deformed but coherent core of the S. bullet. This missile passed through a soldier's neck and killed him; it then lodged in the arm of another and divided the musculo-spiral nerve. (b) The English service bullet, Mark vii, in section, showing the aluminium cone, or jockey.

(c) The lead core may break up into pellets. This is known as fragmentation.

The globular shrapnel bullet rarely breaks up in the body; it does not obtain sufficient velocity.

A bullet fired from a rifle has two motions, one of translation in its long axis and the other of rotation on its long axis. Occasionally a bullet spins on its short axis, a motion commonly referred to as a somersault. Briefly, mantled bullets on impact may retain their shape, or strip. If they strip the mantle curls
up and the lead core may remain coherent, or break up into pellets. The effect on living tissues depends on the behaviour of the bullet. The deformation of a bullet probably depends on the resistance of the body and the velocity on impact. This is, in some measure, supported by the condition of impacted bullets which have somersaulted. These bullets are usually embedded in bone. A bullet that spins on its transverse axis is a bullet moving with much less velocity than one rotating on its long axis. Thus the former on striking a bone embeds itself, whilst the latter may perforate the bone, fracture it, or convert a segment of it into bits.

FIG. 7.—Fragments of an astragalus traversed by a bullet. It was broken into seven pieces. Excised from an officer sniped at Gallipoli.

The reversed bullet in fig. 3 embedded itself in the astragalus. Compare this with the astragalus, fig. 7. In this case an officer was sniped at Gallipoli, April 28, 1915. The bullet entered the astragalus near the external malleolus, emerged below the inner malleolus, and broke the astragalus into seven pieces. These I excised, May 24; the fragments were soft and the pieces of bone were kept coherent by the articular cartilage. The other tarsal bones were intact.

It is necessary to emphasize this, because a report has been circulated that the German soldier, with the idea of increasing the damage caused by the S. bullet, pulls it out of the cartridge case and re-inserts it base foremost. Such a manoeuvre diminishes its velocity, accuracy of fire, and maiming powers. Observations on wounded soldiers show conclusively that bullets reversed on entering the body do less damage than those entering point foremost.

In civil practice, a comminuted fracture with little displacement of the fragments will, in most cases, unite; the bony fragments, soldered together with callus, make a rough but efficient bond of
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union, and a useful limb is the result. In compound fractures the effects are different, especially if the wound become septic. The detached pieces of bone die and the broken ends of the shaft necrose. The majority of bullet-fractures acquired in this war become septic, and afford many opportunities for surgeons to acquire a knowledge of the unfavourable conditions of wounds prevalent in pre-Listerian times.

The method that gives me best results in septic bullet-fractures is to open up the wounds and remove the detached fragments; then thoroughly flush the cavity with solution of peroxide of hydrogen, or tincture of iodine, and drain the cavity freely. These stinking wounds, as a rule, quickly sweeten and granulate.

A severe case of bullet wound of the scapula came under my care shortly after the battle of Neuve Chapelle, March 11, 1915:—

E., aged 44, received a bullet in the right axilla; it passed through the middle of the scapula. The man was left on the field as dead. About forty-eight hours later, hearing some men talking he shouted to them, and was recognized by a soldier belonging to his own company. A stretcher party brought the wounded man into the lines. Eight days later he came under my care, very ill and rambling. There was a small hole in the axilla and a large oval opening on the skin overlying the scapula; through this opening bubbles of gas escaped. On culture, the stinking pus yielded streptococci, coliform bacilli of two varieties, and Bacillus capsulatus aerogenes. Fragments of bone could be seen in the wound, and a radiogram showed that the scapula was broken into many pieces. I excised the scapula (fig. 8). There was a large abscess in the suprascapular fossa, one in the infrascapular fossa, and the shoulder-joint contained pus. The joint was infected through the line of a fracture involving the glenoid fossa. A peculiar feature of each abscess in this case was the presence of a thick membrane of the same consistence as the white of egg when boiled. On opening the shoulder-joint the capsule was lined with this material in such a way that I thought an echinococcus cyst had been opened. The patient made a quick and uneventful recovery with a useful arm, for none of the main nerve-trunks were injured.

This scapula differs in an important particular from all other badly fragmented bones I have examined. When a bone is broken into many small pieces, if the radiogram be carefully examined many small leaden pellets can be seen scattered among the pieces of bone. I feel sure that in many examples of severe fragmentation of bone the damage is often caused by the breaking up of the leaden core of
the bullet after its mantle has been stripped off. This view is supported by observations on the wounds of bone caused by shrapnel bullets. These bullets, as far as I can ascertain from the wounds of soldiers under my care, rarely break up; yet they move with a velocity that enables them to perforate the shaft of the femur.

The destructive effects of bullets on the bones of the upper limb, although they necessitate the removal of considerable portions of the joint-ends of the bone, can often be treated on conservative lines, even when septic, and leave the soldier with an impaired but useful limb. It is otherwise in the case of the lower limb. Extreme comminution of the bones at the ankle and at the knee, especially when the wound is septic, leads to amputation, and the damage caused to the head of the femur, the acetabulum, and adjacent parts of the pelvis occasionally ends, even with all the resources of modern surgery, in death. Those who survive are often impeded with a cumbersome and useless limb, after a prolonged and very distressing
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illness. The femur is very frequently broken by bullets and such fractures are very serious and dangerous. Wounds of the upper end of the femur, especially if they involve the hip-joint, are very fatal injuries.

C. G. Spencer, in his "Manual on Gunshot Wounds," recommends that all septic fractures require exploration; the exit wound must be opened up and all loose fragments removed. Necrotic pieces of bone give endless trouble and keep the sinuses open for months or years, and repeated operations are required for their removal. Detached fragments of bone can be found easily within a short time of the injury, but when they become surrounded with callus they require a long series of troublesome operations for their removal. This excellent advice may be crystallized thus: *Prompt removal of loose fragments of bone saves the soldier much suffering, shortens convalescence, and lessens the risks of secondary hemorrhage.*

A good radiogram is of the utmost service to the surgeon when removing fragments of bone. I always have it in the operating room at the time of the operation and use it as a chart. In this way the pieces of bone can be removed with a minimum disturbance of the soft parts.

A remarkable feature of septic gunshot fractures is the rapidity with which the osseous tissue softens; this is well illustrated in the following cases:

A soldier, aged 25, was hit in the hip by a bullet at Ypres. Ten days later the wound was explored, and the bullet removed from the neighbourhood of the hip-joint. Twenty days later a radiogram showed a fracture involving the acetabulum. As the man did not improve I explored the wound, and found that a piece of bone had been broken from the edge of the acetabulum; the joint was septic. Three weeks later (eight weeks after the injury) a radiogram showed that the head of the femur had disappeared and the neck of the bone was resting on the back of the ilium. I excised the upper end of the bone at a point half an inch below the lesser trochanter. The head of the femur and the subjacent portion of its neck had been completely digested by the action of microorganisms in less than two months. The soldier slowly recovered.

A remarkable example illustrating the disorganizing effects on bone of micro-organisms is represented in fig. 9. A soldier, aged 19, was hit in the right buttock by a bullet. It entered the hip-joint and chipped a piece off the head of the femur and fractured the acetabulum. At the 3rd London General Hospital he came under
the care of Lieutenant H. A. Lucas. A month after the injury the wounds were suppurating freely, the soldier was in a gravely septic condition, and a radiogram showed a dislocation of the hip-joint. Lieutenant Lucas excised the upper end of the bone and found the disk-shaped epiphysis of the head of the femur lying loose in the acetabulum.

![Figure 9](image)

**Fig. 9.**—The head and a portion of the neck of a femur. The hip-joint was damaged by a bullet, and the epiphysis of the head of the bone, separated by a septic process, lay loose in the acetabulum. From a soldier, aged 19.

It is a matter of common observation that gunshot wounds of the leg are more serious than those of the arm. This difference is expressed in the Italian epigram:

\[
\text{Braccio in petto,} \\
\text{Ma gambe in letto.}
\]

(Arm on the breast, but leg in bed.) Wounded in the arm a soldier can walk about; wounded in the leg he must rest in bed.
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