**SPECIMENS OF GUNSHOT INJURIES OF THE
FACE AND SPINE,
CONTAINED IN THE ARMY MEDICAL COLLECTION NOW ON EXHIBITION
IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.**

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THIS article is a continuation of the series commenced in the April number of this journal. In these articles a description is given of the more typical specimens contained in the War Office Collection of pathological specimens. The Collection has been prepared and placed on exhibition in the Museum of the Royal College of Surgeons of England. Its final destination has not yet been settled.

In the last number of this journal we gave an account of the more typical gunshot injuries of the cranial part of the skull as illustrated by macerated specimens. In the present paper we propose to describe briefly some of the more typical lesions of the facial part of the skull, and also certain specimens which illustrate the injuries of the spine. We have confined our attention to the macerated specimens only; but visitors to the Collection will do well to study the facial injuries which Prof. S. G. Shattock and Mr. Cecil Beadles have mounted in the 'wet' series, and also examine the excellent war models prepared under the care of Major A. C. Valadier, C.M.G., to illustrate gunshot injuries of the face and the results obtained in their treatment by plastic operations. There are also very complete series of casts and photographs showing the methods adopted by Captain Derwent Wood, A.R.A., at the Third London General Hospital, to mask deformities which follow facial injuries.

**GUNSHOT INJURIES OF THE
FACE.**

Gunshot injuries of the face have offered a special opportunity to the surgeon to carry out reparative operative procedures, and the improvement which has been made in plastic surgery during the War has been remarkable. Several workers have made special study of the underlying injuries to the bone, and the War Office Collection has been enriched by many specimens collected by these workers. There are 37 specimens showing gunshot injuries of the facial bones. The

FIG. 39.—No. 2.201. Anterior view of cranium, showing injury to both orbits. The arrow shows direction of missile.

specimens have been roughly classified according to the particular area of the face injured, i.e.: (1) *Orbit*; (2) *Maxilla*; (3) *Mandible*.

1. INJURIES TO THE ORBIT.

Twenty-one specimens in the collection show injury to the orbit, and of these, three show damage to both orbits.

Specimen No. 2.201 (*Fig. 39*) is that of a transorbital gunshot wound with destruction of the floor of the right middle cranial fossa. The soldier was wounded on July 1, 1917, and admitted to No. 4 General Hospital in an unconscious condition, with apparently

FIG. 40.—Drawing of patient before death, showing facial appearance and extent of superficial injury.

a fracture of the base of the skull. *Fig. 40* is from a drawing of this patient by Mr. Maxwell, R.A.M.C., showing his condition when admitted to No. 4 General Hospital. There was a pulsating exophthalmos of the right side, which, later, began to discharge externally. Death took place three days after injury, from meningitis. At autopsy, the inferior surface of the right temporal lobe was found to be destroyed and covered with an extra-

and intra-dural hæmorrhage. The missile entered the left eyeball, perforated the inter-orbital septum, and made an exit in the right temporosphenoidal region. There is marked destruction of the interorbital septum, ethmoidal and sphenoidal sinuses, and the floor of the right orbit. There are multiple secondary fractures in the floor of the anterior cranial fossa, cribriform plate, right middle cranial fossa (of which the anterior portion is absent), and of the calvaria in both the frontal and occipital regions. The right malar bone shows fracture of both its zygomatic and frontal processes, being entirely loose from its attachments, except that of the right maxilla. The latter bone shows loss of its orbital surface and a complete fracture through the body. This specimen is of interest as showing an indirect fracture of the right maxilla and processes of the right malar bone, and it is suggested that the soft tissues of the orbit may have aided in producing this result. The fracture of the basis cranii was apparently due to direct impinging of the missile against the floor of the right middle fossa. The vertex of the skull was also fissured by indirect force, in its frontal as well as its occipital region.

Specimen No. 1.7125 (*Fig. 41*) is that of a temporo-orbital wound of the skull, evidently caused by a bullet which entered 1 inch above and in front of the right auditory meatus and made its exit through the left orbit. The aperture of entrance, irregularly triangular (15 by 15 mm.), seems to be so shaped from the oblique tangent of impact. It will be seen that the missile left the cranial cavity by the right sphenoidal fissure, ploughed across the interorbital septum (ethmoid), and came out on the nasal side of the left eye. The patient was admitted to No. 3 General Hospital, on Sept. 5, 1918, and died Sept. 7. He was blind, the left eye being disorganized, and he had symptoms indicating a cerebral irritation. The under surface of the right temporal lobe was found to be lacerated, and there was an extensive subdural hæmorrhage.

FIG. 41.—No. 1.7125. Right anterolateral view of cranium, showing perforating gunshot wound involving both orbits. The arrow indicates direction taken by missile.

From the aperture of entrance two short fissures run, one to the base of the zygoma and the second upwards to the lamboid suture, which is separated for 3 cms. in length, forming a 'T' with the main fissure. The interesting feature of this specimen is the slight injury to the bony walls of the orbits compared with the extensive injury seen in specimen No. 2.201 (*Fig. 39*). The base of the cranium shows comparatively slight fissuring, and no indirect fracture of the facial bones has occurred. Incidentally we may mention that this specimen shows that the malar bones possess a texture quite different from that of the other bones of the face. The skull had been cleaned in calcium chloride solution, which has changed the texture of all bones save the malars.

Specimen No. 2.202 (*Fig. 42*) shows an extreme injury to both orbits and the bones of the face. The missile entered the outer wall of the right orbit at the fronto-malar

junction, and, passing through both orbits and interorbital septum, made its exit on the left cheek over the prominence of the left malar bone, which has been markedly comminuted and carried away. Extreme comminution of all the facial bones, and of the floors of the anterior and middle fossæ of the basis cranii, has taken place. The two palatine bones

show transverse fracture, and it has so resulted that the palatal and alveolar portions of both maxillæ have been entirely separated from the remaining portion of the skull.

Fracture lines extend upwards from the anterior fossæ through the frontal bone, and, although the specimen is incomplete, it is apparent that the anterior portion of the frontal bone, including the supra-ciliary ridges and orbital margins, has been separated from the remaining portions of the cranium.

The patient was wounded on July 10, 1917, and, in spite of the extensive injury to the basis cranii, lived for thirteen days. There was destruction of both eyeballs. He died on July 23, of meningitis. The bones of the cranial cavity are thin, and those of the face are delicate, features which are contributory to the extent of the injury.

FIG. 42.—No. 2.202. Anterior view of skull, showing trans-orbital gunshot injury, with extensive comminution of walls of both orbits and bones of face. The palatal portion of the two maxillæ is separated from the superior portion of skull.

Specimen No. 2.207 (*Fig. 43*), consists of the anterior portion of a cranium which shows an extensive comminution of the right orbit by a shell fragment that lodged in the soft tissues at the superior medial angle of the orbit.

The soldier was wounded on June 30, 1917, and the right eye removed at a casualty clearing station a few hours afterwards. He was transferred to No. 4 General Hospital, where he died on July 8 from suppurative meningitis. The missile entered the right side of the face in front of the angle of the lower jaw, carrying away the right coronoid process. It passed upwards through the lateral wall of the right orbit, and struck the frontal bone at the superior medial angle of the orbit, perforating the frontal sinus and floor of the anterior cranial fossa. The latter shows marked comminution. The anterior tip of the right frontal lobe of the brain was lacerated, and portions of indriven bone were found embedded in it. The floor of the right orbit has been shattered, and a complete fracture of the body of the right maxilla has occurred, with loss of the anterior wall of the right antrum for an area of 12 by 5 mm.

In specimens Nos. 1.7125, 2.201, and 2.207, the missile in each case has entered one or both orbits. The War Office Collection

FIG. 43.—No. 2.207. Anterolateral view of cranium, showing extensive comminution of right orbit. The missile (a fragment of shell) can be seen at the superior medial angle of right orbit.

contains two specimens in which the injury has been caused by a glancing blow from a shell fragment, and in which the lateral wall of an orbit has been carried away.

Specimen No. 1.7135 is one of this type. There is a temporo-orbital wound of the left side of the face. The missile, a large shell fragment, evidently came from a posterior direction and, hitting a glancing blow, carried away a portion of the left temporal bone, the entire left zygomatic bone, left great wing of the sphenoid, and the superior wall of the left maxillary sinus.

The soldier, a German prisoner-of-war, was admitted to No. 3 General Hospital on Aug. 12, 1918, with a very septic wound. The left eye was severely lacerated, and was excised. He died suddenly on Aug. 15, from massive gas gangrene. No illustration is given of this specimen.

In the specimens described we have been rather more interested in direct injuries of the orbit; but one must also take into consideration a rather large group of specimens in which there has been an involvement of the orbit by a fracture or fissure radiating from, and continuous with, a primary injury to another area of the cranium. Unfortunately many specimens showing gunshot injuries of the calvarium are incomplete, the orbital portions not being preserved. In the Collection twelve specimens show this secondary involvement of one or both orbits. Of the twelve cases, nine present a direct injury of the frontal bone, two of the parietal, and one of the temporal. It would seem that secondary involvement of the orbit was much commoner in direct injury to the frontal, but also does occur from injury to other bones of the calvarium.

These secondary fractures and fissures radiating into the orbit have been described by some writers as indirect. Whether such a fracture produced disturbance of vision in any of the cases concerned could not be determined from the available histories. Where such a fissure involves the sphenoidal foramen and track of the optic nerve, one would reasonably expect symptoms of disordered vision.

One specimen in the collection (No. 1.77), is remarkable in presenting a severe injury to the left superciliary ridge down to the left orbital margin of the frontal bone, but in which there has been no involvement of the roof of the orbit. The injury was evidently a contused one, occurring in a thin frontal bone, no radiating fissures being produced.

The Collection has one specimen (No. 1.0221, *Fig. 473*, BRITISH JOURNAL OF SURGERY, vol. vi, p. 558) which is an example of pure indirect fracture of the left orbit. The chief wound, an aperture 52 by 20 mm., is situated on the temporal surface of the left parietal bone. From this aperture radiate into the skull five fissures—one extending through the ear to the base, another to the occiput, and a third to the left superciliary ridge. Besides this main series of fissures, there are secondary fissures in the roof of each orbit, on the floor of the right middle fossa of the skull, and in the right maxilla. The injury was due to a direct blow from a large shell fragment which did not lodge. The indirect fissures of both orbits and of the right maxilla were apparently due to 'explosive effects' of a peculiar kind. The right anterior sphenoidal fissure was involved in the indirect fissure of the right orbit.

Specimen No. 1.023 (*Fig. 471b*, BRITISH JOURNAL OF SURGERY, vol. vi, p. 557), is also an interesting specimen as showing a marked destruction of both orbits by the explosive effects of a rifle ball fired at close range. The bullet entered the mouth, passed through the base of the skull, and made an exit near the left parietal eminence.

2. GUNSHOT INJURIES OF THE MAXILLA.

The War Office Collection contains sixteen specimens showing a direct injury to the upper jaw. It must be noted that many of these cases show secondary injury to other bones of the face and cranium. Five of the specimens are perforating, through-and-through injuries in which the missile passed through both maxillae.

Specimen No. 2.3455 (*Fig. 44*) is an example of a through-and-through wound, attended by an extensive destruction of the face. The missile, a bullet, entered the left cheek below the left inferior orbital margin and came out below the right malar eminence. The alveolar

portion of the upper jaw has been entirely separated from the orbits and nose, and the floor of the right orbit has been carried away. The medial wall of the right orbit, the vomer, and ethmoid bones have been comminuted. The soldier, a German prisoner, was

admitted to No. 3 General Hospital on Sept. 3, 1918, with multiple septic wounds, and died on Sept. 8 of septic bronchopneumonia.

Specimen No. 2.441 (*Fig. 45*), is a good example of a direct injury to the left maxilla. A small missile, probably a fragment of shell, has perforated the anterior wall of the left maxillary sinus, passed along the inner wall of the left orbit, breaking the left mass of the ethmoid, and has entered the skull through the cribriform plate. There is comparatively little fissuring of the surrounding bones, the right orbit being intact. The soldier was wounded on June 11, 1917, and died the next day. The foreign body was not located, but the right frontal lobe was found to be lacerated, and contained a sinus along which the missile passed. An interesting feature in this case is the clean type of perforation of the maxilla, without fissuring.

FIG. 44.—No. 2.3455. Anterior view of cranium, showing extensive destruction of face by a missile which perforated the upper jaw.

Specimen No. 2.431 (*Fig. 46*) is one of multiple wounds of the face and head caused by fragments of shell. There are three main wounds, one, of the anterior alveolar portion of the upper jaw, a second, penetrating wound of the body of the right maxilla, and a third, a penetrating wound of the mastoid portion of the right temporal bone. A missile has apparently struck the incisor portion of the upper jaw, which has been carried away. The alveolar portion of the left maxilla, supporting the left canine and premolar with a portion of the body, covering the left maxillary sinus, has been separated from the surrounding bone. The dental splint used to retain the canine fragment *in situ* is still attached to the teeth. A second missile penetrated the body of the right maxilla, producing a clean-cut circular aperture 2 cm. in diameter, passed through the floor and medial wall of the right orbit, and lodged in the sphenoidal sinus just medial to the right optic foramen. The lateral wall of this orbit is not comminuted.

FIG. 45.—No. 2.441. Anterior view of face, showing uncomminuted perforating wound of left maxilla. The line of passage of missile through orbit is indicated by the arrow.

In specimen 2.431 (*Fig. 46*), as in No. 2.441 (*Fig. 45*), the body of the maxilla shows a clean aperture with no comminution. The soldier was wounded on May 31, 1917, and admitted to No. 20 General Hospital on June 5. He had a right facial paralysis and deafness. He developed meningitis and thrombosis of the right lateral sinus due to the mastoid wound, and died of toxæmia on June 26.

The Collection contains one specimen showing indirect fracture of the upper jaw, No. 1.0221, described under indirect fracture of the orbit. This specimen shows a linear fissure 4 cm. in length across the body of the right maxilla, as a result of the explosive effects of a contused injury and fracture of the left parietal bone.

In examining the histories of the cases which show injuries to the upper jaw, it is interesting to note that death occurred from secondary hæmorrhage in many of these cases, several days after injury.

3. GUNSHOT INJURIES OF THE MANDIBLE.

The War Office Collection contains twenty-two specimens of gunshot injuries of the lower jaw. Considerable progress has been made during the war in methods for the splinting of fragments of the mandible and their treatment, and in several specimens in the Collection one sees the dental splint, applied during life, still in position.

We have divided fractures of the mandible into three groups according to the anatomical position of the injury, i.e.: (1) *Anterior*, those occurring along the line and in the neighbourhood of the symphysis; (2) *Lateral*, where the body of the mandible is chiefly involved; and (3) *Superior* group, where the ascending ramus and its processes are involved. This classification is essentially an anatomical one, but has an advantage clinically as well, when one considers the functions of the three main portions of the mandible. In each of the above groups the Collection presents specimens which represent various grades of injury, and we have recognized complete fracture of the mandible, partial fracture, and complete fracture in which there is considerable loss of bone. In the case of the ascending ramus, fracture of either the coronoid or articular process has been considered as a partial fracture. Three specimens show fracture of both bodies, caused by through-and-through wounds.

1. Anterior Injuries to the Mandible.—There are nine specimens showing injury with fracture in the neighbourhood of the symphysis.

In specimen No. 2.7701 (*Fig. 47*) there is a comminution of the symphyseal region of the mandible, caused by a fragment of high-explosive shell which struck the point of the chin. The soldier, age 28, was brought in dead on Nov. 23, 1917, to No. 3 General Hospital. He had died of hæmorrhage into the thorax caused by another wound. The missile has carried away a triangular area of the chin, and the inferior margin of the body.

FIG. 46.—No. 2.431. Anterolateral view of cranium, showing multiple injuries. Note anterior dental splint applied to retain the canine fragment in position.

on each side of the symphysis, has been shattered into several fragments. From the apex of the triangle, a gaping fissure extends through the body between the left lower canine and the left lateral incisor.

FIG. 47.—No. 2.7701. Anterior view of a mandible, showing comminution of the chin.

FIG. 48.—No. 2.784. Mandible, showing complete and probably indirect fracture in the region of the symphysis, without comminution.

Specimen No. 2.784 (*Fig. 48*) is an instructive one. There is a complete fracture through the body of the mandible extending from the socket of the right lateral incisor to the lower border of the symphysis. The two right lower incisors are missing, apparently from the injury. There is no comminution of the surrounding bone, and no abrasion of the surface of the bone can be seen; yet the history states that on admission to No. 3 General Hospital, April 30, 1917, there was a linear wound extending downwards through the lower lip for a distance of two inches. There was also a severe injury of the left orbit, and the patient died on May 4 of meningitis, by extension from the orbit through the cribriform plate. It is suggested that in this case the fracture was due to the lateral pressure of the soft tissues—the missile not striking the bone. One not unusually sees a similar type of fracture in the calvarium, and even in the long bones of the body.

In specimen No. 2.781 (*Fig. 49*) we have an example of comminuted fracture of the lower jaw in which there is considerable loss of the substance of the bone. The missile seems to have hit the surface of the mandible perpendicularly. The incisor region of the right side and the incisor and premolar region of the left side have been destroyed, representing a space, about 3 cm. in length, through the full thickness of the body. A fissure extends from the inferior end of the right lateral margin of the aperture, backwards through the right lateral body for a distance of 3 cm. The mandible is of a thin undeveloped form, from a soldier, age 25, who was wounded on April 28, 1917, in several places, and died on May 9 of septic bronchopneumonia.

FIG. 49.—No. 2.781. Mandible, showing comminuted fracture in region of the symphysis, with considerable loss of continuity. The arrow indicates direction missile was travelling.

It is unfortunate that the War Office Collection does not contain a specimen showing partial fracture of the symphysis.

2. Injuries to the Lateral Portion of the Mandible.—There are ten specimens showing gunshot injury of the lateral portion of the mandibular body.

In specimen No. 2.7544 (*Fig. 50*) there is a marked comminution of the left molar-angular region of the mandible caused by a fragment of shell. The left ramus is entirely separated from the body, and the latter, for a distance of 4 cm., has been shattered into

four fragments. Fissures radiate from the site of perforation into the ramus. The missile passed entirely through the body, lacerating the dental nerve and artery, and escaped on the right side of the neck, injuring the sympathetic trunk and cervical spine. The soldier was wounded March 15, 1917, and died Aug. 23, from a secondary hæmorrhage.

FIG. 50.—No. 2,7544. Left lateral view of mandible, showing extensive comminution of left molar-angular region caused by fragment of shell which perforated the body.

FIG. 51.—No. 2,755. Left lateral view of mandible, showing complete fracture in region of left premolar and first molar. Dental splint still *in situ*.

Specimen No. 2,755 (Fig. 51) presents a complete fracture of the body of the mandible in the region of the left premolar and first molar. The missile struck the bone near the lower border and passed towards the floor of the mouth. The inner or splenial table of the mandible is broken away and shattered; the inferior dental canal and vessels were ruptured and exposed. Fissures pass forwards and backwards from the site of fracture. The specimen is of special interest in that the dental splint made for this case has been left *in situ*. The soldier was wounded March 23, 1917; four days later he developed septic pneumonia (streptococcic), and died April 2.

In specimen No. 2,7554 (Fig. 52) we find a complete fracture of the right side of the body of the mandible, produced by the impact of a shell fragment (size 26 by 14 by 9 mm.). The missile struck the inferior margin of the body at the level of the right mental foramen,

FIG. 52.—No. 2,7554. Mandible, showing a complete fracture some distance posterior to point of impact of missile. The missile, a large fragment of shell (26 by 14 by 9 mm.), is shown below mandible.

FIG. 53.—No. 2,801. Mandible, showing double fracture of right body.

shattering the margin for a distance of 4.5 cm. into several fragments, which have become detached. From the posterior end of the shattered area, a vertical complete fracture has been produced. This fracture line is 33 mm. from the point of impact of the missile.

The missile has been preserved. The soldier was wounded on Nov. 29, 1917, and died at a casualty clearing station one hour afterwards. It was found that the missile had glanced off the mandible and torn across the right carotid artery and jugular vein.

Specimen No. 2.801 (*Fig. 53*) illustrates a double fracture of the mandible caused by a blow with the butt end of a German rifle. The soldier was injured Oct. 26, 1917, and died in two days from generalized gas-bacillus infection. There are two complete fractures through the right body, one from the socket of the third right molar to just in front of the angle, and a second from the right anterior premolar to a point 6 mm. from the inferior end of the symphysis. From the posterior line of fracture, a fissure of the lateral plate of the body extends down to its inferior margin. The bone shows no indication of the point of impact of the weapon.

FIG. 54.—No. 2.758. Mandible, showing destruction of left half of body, with comminution of symphyseal region.

Specimen No. 2.758 (*Fig. 54*) shows an extreme comminution of a mandible, with considerable loss of bony tissue. The soldier was wounded Oct. 9, 1917, and on admission to hospital had a gunshot wound extending from the left angle of the mouth to the lower

FIG. 55.—No. 2.754. Mandible, showing triple fracture produced by perforating bullet wound. The arrow indicates direction of the missile.

submaxillary region of the neck. Ten days after injury he developed a severe secondary hæmorrhage from the left facial artery. He died on Nov. 1 from bronchopneumonia. The wound of the face had begun to heal. The body of the mandible from the left pre-molar region to the base of the right coronoid process is markedly comminuted. Five

cms. of the left side of the body are missing. This case is remarkable in the extent of loss of continuity of the bone.

The War Office Collection contains three specimens of perforating gunshot wounds involving both sides of the body.

No. 2.754 (*Fig. 55*) is a good example of this type. The missile, a bullet, entered the mandible on the right side below the second molar and emerged on the left at a nearly corresponding point, perforating the base of the tongue in its passage. The right and left rami have been detached, and fissures ascend into them. There are three complete fractures, one at each of the points of entrance and exit, and a third at the symphysis, which has been produced by indirect violence. The soldier was wounded on April 14, 1917, and died two days later.

3. Injuries to the Ascending Ramus and Processes.—In specimen No. 2.721 (*Fig. 56*), the superior portion of the angle of the right mandibular ramus has been detached and broken by a bomb fragment. No fissures extend into the main portion of the ramus. A history of this case is not obtainable.

FIG. 56.—No. 2.721. Mandible in which a fragment of the angle has been detached. The arrow indicates direction taken by missile.

FIG. 57.—No. 2.739. Fracture of left condyle of mandible by shell fragment.

In specimen No. 2.739 (*Fig. 57*) there is a comminuted fracture of the left condyle of the mandible, by a fragment of shell which entered at the back of the neck, near the middle line. The soldier was wounded on June 28, 1917, and died on July 8 of secondary hæmorrhage. The left internal carotid and vertebral arteries were lacerated by the missile in its passage through the neck.

FIG. 58.—No. 2.705. Mandible, showing fracture of upper part of left mandibular ramus. The missile, a fragment of shell, is shown near the medial side of right ramus.

Specimen No. 2.705 (*Fig. 58*) shows a fracture of the upper part of the left mandibular ramus by a fragment of shell, which crossed the pharynx and then became lodged on the

deep aspect of the right ramus. The missile has perforated the left ramus at the lower margin of the sigmoid notch, carrying away a portion, and breaking the coronoid process at its base. The soldier, age 25, was admitted to hospital Oct. 16, 1917. The external carotid artery was tied on account of hæmorrhage, and there was also a left facial paralysis. A secondary hæmorrhage developed on Oct. 24, for which the left common carotid artery was tied. A right hemiplegia followed, with complete aphasia. Death occurred on the same day, the result of a further secondary hæmorrhage.

FIG. 59.—No. 2.751. Mandible, showing comminution of left ramus, only the condylar process and angle remaining. The dental splint attached to lower teeth was used to fix mandible to upper jaw.

FIG. 60.—No. 2.748. Comminuted fracture of left mandibular ramus, with detachment of condyle. Direction taken by missile is shown by the arrow.

Three specimens in the collection show marked comminution and shattering of an ascending ramus. In No. 2.751 (*Fig. 59*) the left ramus has been largely carried away, only the condylar process and angle remaining. The latter is undergoing absorption. A fissure passes along the body of the jaw from the site of fracture to a point just posterior to the left mental foramen. The inferior dental canal is exposed. The right ascending ramus is seen to be fragile and very much under-developed. The soldier was wounded April 2, 1917, by a bullet which entered the left cheek and passed out at the angle of the right ramus. He died on April 29, of septicæmia.

Specimen No. 2.748 (*Fig. 60*) presents a similar but more extensive comminution of the left ramus. The condyle is detached and the coronoid process largely carried away. There is also a complete fracture of the body at the level of the third left molar. The specimen is of special interest in showing comminution of the right body, with two complete fractures, due to indirect violence. The alveolar portion supporting the two premolars is loosened from its attachment. The soldier was wounded on April 12, 1918. The bullet entered the right side of the neck, perforated the tongue and floor of the mouth, and ultimately produced fracture of the left ramus.

FIG. 61.—No. 2.7845. Skull, showing extensive fracturing of the facial bones and ramus of the mandible by a shell fragment.

Specimen No. 2.7845 (*Fig. 61*) is one in which there has been extensive fracturing of the face by a fragment of shell. The right malar bone and part of the right ascending ramus, including the condylar neck, have been carried away. There is a second fracture through the right body near the posterior molar region, and in this way a large segment of the ascending ramus and angle has been displaced from its normal position. The missile apparently struck the right malar eminence from in front. The extent of the lesion is probably due to the edentulous condition of the soldier and the thinness and delicacy of the facial bones.

FIG. 62.—No. 2.754. Comminuted fracture of right ramus, caused by a missile which struck at base of coronoid process.

In specimen No. 2.754 (*Fig. 62*) the missile, a shell fragment, has perforated the right ascending ramus near the base of the coronoid process, carrying away a considerable portion of the latter. The angle and the condylar process have been detached, and the remainder of the ramus reduced to fragments. The soldier was wounded on May 14, 1917. On May 18 he developed a secondary hæmorrhage from the external carotid, which was tied; he died the following day.

GUNSHOT INJURIES OF THE SPINE.

The War Office Collection contains 50 specimens showing a wide variety of spinal injuries produced by various missiles. The collection has recently been enriched by 15 specimens forwarded from No. 3 General Hospital. A description of some of these has already been given by Colonel William Thorburn, C.B., and Major George Richardson (*BRITISH JOURNAL OF SURGERY*, vol. vi., p. 481). Visitors to the collection are advised to study the specimens in conjunction with the pathological findings in the spinal cord given in the above-mentioned article. In the 'wet' series several spinal cords have been cut transversely, and segments have been removed and mounted beside the cord, showing intraspinal hæmorrhage caused by indirect force where the injury has not directly involved the spinal canal. For purposes of description the specimens have been classified on an anatomical basis, that is, according to the portion of vertebral column chiefly involved.

Injuries to Cervical Region of the Spine.—There are ten specimens in the Collection showing injury to the cervical vertebræ. It is interesting to note that only one of these shows an injury to the axis (comparatively slight), and none show injury to the atlas. The majority of injuries are those of the four lower cervical vertebræ. This may be explained by the fact that the specimens are from cases which reached at least an advanced base hospital. The higher and more rapid mortality in cases of injury to the proximal vertebræ prevented the cases from reaching the collecting centre. It is also to be noted that none of these show a perforating (through-and-through) injury in which the spinal cord would have been entirely cut off. The injuries are chiefly due to tangential blows where it is probable that considerable portions of the cord were still intact, enabling life to continue for several days or weeks.

In specimen No. 3.24 (*Fig. 63*) the bodies of the fifth and sixth cervical vertebræ and intervening disc have been almost completely destroyed by a glancing blow from a bullet which entered the pharynx and made an exit near the spine of the 3rd dorsal vertebra. The soldier was wounded on July 15, 1915. He developed a paraplegia with some loss of

FIG. 63.—No. 3.24. Anterior surface of cervical vertebræ, showing partial destruction of the bodies of the 5th and 6th vertebræ.

sensation, and died on July 24; an abscess was found in the spinal canal at the site of the injury, which involved the cord.

Specimen No. 3.21 (*Fig. 64*) shows a fracture of the transverse and articular processes on the left side of the 3rd cervical vertebra caused by a bullet. The missile apparently came from behind, carrying away the tip of the spinous process of the axis, and the processes on the left side of the 3rd vertebra. A portion of the left pedicle has also been destroyed. Spinal meningitis developed, causing death.

Injuries to the Dorsal

Vertebrae.—Specimen No. 3.37 (*Fig. 65*) is an interesting one showing the extensive injury which may be produced to the spine by a rifle bullet. The soldier was apparently lying down, and the missile, striking the spine of the second dorsal vertebra, travelled along the line of the vertebral column, and shattered the pedicles and the spinous and left transverse processes of all the dorsal vertebrae from the 2nd to the 9th, making its exit in the region of the 9th. The missile evidently at no point entered the spinal canal. The bodies of the 3rd to the 9th dorsal vertebrae, inclusive, show complete vertical fracture. A history of this case is not available.

Specimen No. 3.3622 (*Fig. 66*) is an example of a trans-spinal injury in which the spinal cord was entirely cut across. The missile, a bullet, passed in an oblique direction, entering above the left clavicle and emerging on the back, to the right of the 10th dorsal spine. It struck the left pedicle of the 4th dorsal vertebra, fracturing the head of the rib, entered the spinal canal, and made an exit in the region of the right articular process of the same vertebra, shattering the right transverse process and lamina. The soldier was wounded on Nov. 23, 1917,

and died on Dec. 5. He had paralysis below the waist line, with retention of urine and faeces. There was also a left hæmothorax, with an empyema on the right.

Specimen No. 3.38 (*Fig. 67*) exhibits a more extensive injury than that seen in No. 3.3622 (*Fig. 66*). The missile, a rifle bullet, struck the 12th dorsal vertebra at about the same point as in No. 3.3622, and made its exit between the left articular

FIG. 64.—No. 3.21. Cervical vertebrae, showing fracture of transverse and articular processes on left side of 3rd vertebra.

FIG. 65.—No. 3.37. Dorsal portion of spine, showing extensive fracturing of pedicles and spinous processes.

FIG. 66.—No. 3.3622. Oblique trans-spinal injury of 4th dorsal vertebra. Aperture of entrance is shown, with portion of left 4th rib *in situ*.

process and spinous process. It apparently just passed through the roof of the spinal

FIG. 67.—No. 3.338. Posterior view of the three lower dorsal and two upper lumbar vertebrae, showing extensive fracture of the vertebral arches of 11th and 12th dorsal vertebrae. The arrow indicates direction taken by the missile.

FIG. 68.—No. 3.3816. Left lateral view of lower dorsal vertebrae and 1st lumbar vertebra, showing trans-spinal injury with perforation of the body of 12th dorsal vertebra. The arrow indicates direction taken by missile.

canal. The head of the 12th rib, and the right pedicle, lamina, and spinous process of the 12th dorsal vertebra, are shattered, and also the inferior left articular process and lamina of the 11th dorsal vertebra. No history of this case could be obtained.

Specimen No. 3.3816 (*Fig. 68*) shows a trans-spinal injury of the 12th dorsal vertebra in which the vertebral arch escaped with but slight injury, while the body has been perforated and fractured. The missile, a rifle bullet, entered the spinal canal through the 11th interlaminar space, just to the right of the 11th spinous process, perforated the body, and ultimately lodged beneath the left nipple. The spine of the 11th dorsal and the left pedicle of the 1st lumbar vertebrae have been fractured by indirect force. The soldier was wounded on Oct. 10, 1917, and admitted to hospital the next day with complete paraplegia and incontinence of urine and faeces. He died on the 22nd from sepsis and infected hæmothorax. The spinal cord was found to have been completely severed at the level of the injury. It has been preserved and mounted in the 'wet' series of the War Office Collection.

Injuries to the Lumbar Portion of the Spine.—In the War Office Collection there are 15 specimens with gunshot injury to the lumbar vertebrae. In 5 of these the injury to the spine is associated with an injury to the pelvic bones, the missile first striking the pelvis in each case. In these specimens the pelvis has been mounted with the sacrum and lumbar vertebrae.

FIG. 69.—No. 3.421. Posterior surface of the upper part of the lumbar spine, showing a gunshot injury of the body of the 1st lumbar vertebra in which a laminectomy had been performed, followed by partial repair.

No. 3.421 (*Fig. 69*) is an instructive specimen. The patient apparently lived for some weeks, and after injury a laminectomy had been performed on the 1st and 2nd lumbar vertebrae. The missile entered the spinal canal from behind, and penetrating the body of the 1st lumbar vertebra, destroyed and shattered the right half, and produced a vertical fissure through the posterior portion of the body of the 2nd lumbar vertebra. Healing has taken place, with the laying down of an irregular callus plate on the right side of the body of the 1st lumbar, and between it and the body of the 12th dorsal vertebra. The right transverse process, which had been fractured, has been re-united, and the fissure of the body of the 2nd lumbar has been filled in. The bony margins of the laminectomy wound show delicate callus points and some absorption. No further history could be obtained.

FIG. 70.—No. 3.4815. Posterior surface of iliolumbar region, showing extensive injury to pelvis, 5th lumbar vertebra, and sacrum. The direction taken by missile is indicated by the arrow.

Specimen No. 3.4815 (*Fig. 70*) is one of the iliolumbar region showing the injuries produced by a bullet entering from the side. The wound of entrance was in the upper part of the right buttock, and the wound of exit at about the same level of the left buttock. The soldier was admitted to No. 3 General Hospital, Aug. 29, 1918. There was faecal discharge from the wound in the left buttock, paraplegia, and incontinence of urine. He died on Sept. 8 from sepsis with acute cystitis. Note in the specimen the marked difference

in the extent of injury to the right and left ilia. The aperture of entrance, right ilium, is circular, 1 cm. in diameter, and its centre is 15 mm. from the posterior margin of the iliac crest, and 4 cm. above the posterior inferior spine of the right ilium. The missile passed through the bone, forming a circular canal with no fissures except for slight marginal fracture at the medial end. The spinous process of the 5th lumbar vertebra is fractured entirely across at the base, and the arch of the same vertebra is shattered; its inferior portion on the left side, left inferior articular process, and left transverse process are missing. There is some fissuring of the posterior surface and superior portion of the lateral surface of the sacrum on the left side, with loss of an irregular portion of cortex 35 by 35 mm. The missile apparently struck the posterior third of the left iliac crest a glancing blow. The left ilium—superior two-thirds—is broken into several large portions, of which the posterior end of the crest, 6 by 3 cm., is missing. This specimen is instructive in showing extensive injury to the pelvis and sacrum as well as an injury to the lumbar vertebræ.

In a detailed study of the specimens of spinal injury, certain features of importance present themselves. It is noted that in the majority of injuries to the vertebral arch, one finds fissuring of the vertebral body; while in injuries to the body, even when there is perforation, there is seldom any marked fracturing of the arch or processes.

Specimen No. 3.37 (*Fig. 65*) is an excellent example of this secondary fissuring of the body. The history of this specimen is very incomplete, and we have been in considerable doubt as to the mechanism of the injury. We are indebted to Colonel Thorburn and Major Richardson for a probable explanation as to how it was produced. At first we thought that the bullet must have hit the various processes which have been fractured; but the probable explanation is that the fractures were to a large extent produced by the carrying away of the soft parts, thereby tearing off the processes. Also, it is possible that the lateral recoil of the soft parts may have played a part, very much in the way that we have pointed out in the injuries to the mandible and in certain fractures of the calvaria.

Another point we have noticed is that the vertebral body is particularly resistant to direct injury by missiles, even when perforated, as compared with the destruction seen in long bones. This may be explained by the fact that the body is, to a large extent, cancellous, with only a narrow cortex of dense bone. In specimen No. 3.3816 (*Fig. 68*) the body has been completely perforated, yet there is no fissuring except for the marginal bevelling of the cortex at the aperture of exit of the missile.

(To be continued.)