On the probable surgical effects in battle in case of the employment of projectiles of a more elongated form, such as the Whitworth projectiles / by Thomas Longmore.

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Longmore, Sir Thomas, 1816-1895.
Royal College of Surgeons of England

Publication/Creation

[London] : [Printed by Harrison and Sons], [1865]

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IN

PROJECTILES

THE W

Vol V.

[*Reprinted from "Army Medical Report* 1865."]

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THE WHITWORTH PROJECTILES.

ON THE PROBABLE SURGICAL EFFECTS IN BATTLE IN CASE OF THE EMPLOYMENT OF PROJECTILES OF A MORE ELONGATED FORM, SUCH AS THE WHITWORTH PROJECTILES.

By Deputy Inspector-General THOMAS LONGMORE, Professor of Military Surgery, Army Medical School.

GENERAL REMARKS.

CERTAIN features in the wounds produced by cylindro-conoidal projectiles present marked differences, when compared with those produced by spherical projectiles, under the ordinary circumstances of warfare. The larger proportionate number of wounds where the great cavities of the body are opened; the greater number of injuries to the vital organs; the more extensively destructive and fatal effects in wounds of bones, which now occur in engagements where cylindro-conoidal bullets are employed, than were met with formerly when the spherical balls were used; the more extensive laceration of the soft structures owing, not only to the greater destructive power of cylindro-conoidal projectiles and more violent dispersion of the substances struck by them in their flight, such as fragments of bones, but possibly also to the circumstance of their being able to be deflected into a partial rotation on some of their shorter axes, and thus to inflict in their passage through the soft tissues of the body wider spheres of destruction than the sperical bullets, which, from their form, could only present one equal length of diameter in whatever direction they might travel; these are facts which have now become well established by military surgeons.

The following question is now raised :—What will be the probable surgical effects if a still more elongated projectile, such as the Whitworth rifle projectile, be employed?*

It may simplify the means of replying to this question, if I first recapitulate what appear to be those conditions, attached to elongated projectiles in general which influence their power of wounding the human body, and modify the wounds they inflict.†

These conditions are—

(*a*) Degree of Velocity.
(*b*) Form of Apex.
(*c*) Diameter.
(*d*) Length.
(*e*) Hardness.
(*f*) Weight.

The degree of velocity (*a*), form of apex (*b*), and diameter (*c*), chiefly influence penetration. The greater the velocity at the moment of impact, the more pointed the apex of the projectile, and the narrower its diameter, the greater the ease with which the highly elastic skin is perforated, and the inner structures traversed.

* These remarks were written in the year 1862, on two rifle bullets of the Enfield and Whitworth forms being sent to the writer with this query.

† It has been convenient, for the purposes of this paper, to analyze these conditions separately. It seems almost needless to add that the *combined* effects of these conditions would have to be specially calculated. Thus the destructive power from velocity and weight, *i.e.*, momentum, would not be a matter of simple addition, but would have to be calculated by the multiplication of the one condition into the other. The weights of the projectiles referred to in this paper are alike. The ordinary conditions of battle are also only kept in view; were it otherwise, the well-known greater initial velocity of a spherical projectile within a limited number of yards would change many of the conclusions arrived at.

As length (*d*) is increased, so will liability to more extensive laceration of the tissues through which a projectile passes be increased. It is evident that when a cylindro-conoidal projectile, as it ordinarily flies, rotating on its long axis, is suddenly brought into direct opposition and collision with an unyielding substance, whether before or after entering the body, one of three events will occur. *Firstly*, it may perforate the opposing substance and pass on, retaining its original line of flight ; *Secondly*, its progress may be arrested, being itself crushed and flattened, or separated into two or more portions ; or *Thirdly*, it may be caused to pursue its course in a new direction. In this last case, when deflected, its line of flight may be simply altered, its original course of rotation and width of track being preserved : or, its rotation being checked, it may effect an opening for itself sideways, that is, with its long axis at right angles to the line of its course : or the rotation on its long axis may be changed, by the resistance it has met with at its apex, into a partial rotation on one of the short axes.* If this secondarily acquired rotation were to continue for any distance through the body, then the track of the projectile would be rendered equal in diameter to the diameter of a circle of which the *radius* corresponded in length with that of the long axis of the elongated projectiles. This altered rotatory movement of the projectile must be attended with great stretching and tearing of the tissues which immediately surround the tunnelled opening made by the projectile in its passage, and alone can explain the wide laceration met with in the course of some flesh wounds in which the entrance opening corresponds closely in size with a section of the projectile through one of its short axes. Hence the important influence of length.

As hardness (*e*) is increased, in addition to the qualities just mentioned, the greater will be the ease with which the metallic parts of accoutrements, the stronger bones of the extremities, and the vault of the cranium are perforated.

Finally, in addition to the above, as weight (*f*) is increased, so the degree and extent of destruction of the harder structures will be increased.

The primary rotatory motion of rifled projectiles also has an influence on the wounds produced by them, but generally not in any important degree when their original lines of flight and courses of rotation on their long axes are retained throughout their whole course.†

* The frequency with which the *base* of a lodged cylindro-conoidal bullet is presented to the surgeon who has to excise it from the side of a limb opposite to that at which it has entered, is due to this secondarily-acquired rotation on a short axis.

† The influence of rotation on the long axis may be chiefly observed when the apex of a rifle-bullet comes into collision with the sharp edge of a thin bone, as, for example, with the edge of a broken bone of the cranium, and the bullet is partly bisected by its own inherent *vis a tergo*, or forward motion. In such a case, the divided surfaces of the lead are usually strongly marked by ridge and furrow lines, caused by the irregularly jagged edge of the broken bone by which the division has been effected ; and the direction of these lines will frequently serve to illustrate the twisting force—resulting from the rotation of the projectile on its long axis—which has been at the same time exerted. There is a very interesting specimen of a bullet in the museum of the Army Medical Department, connected with a wound of the head, which exhibits nearly one complete turn on its long axis after it had been thus caught. This bullet, a Russian conical rifle-bullet, has been separated by an oblique division from the apex to the base ; and the two divided parts are only held together by a narrow isthmus of lead at one of the angles of the base of the section. This isthmus is twisted round on itself, like a piece of cord, carrying with it the thinner section of the projectile, or that section which was most easily acted upon by the twisting force. The ridge and furrow lines on the separated surfaces of the bullet are contorted from the right to the left, indicating the direction towards which the *rotatory force* has modified the direction of the *bisecting force*. I am not aware that any observation of such a demonstration of the influence of the spinning quality of a rifle-bullet in motion has been before published. Although when the spinning force is first impressed upon the projectile, it is limited by the degree of spirality of the grooves of the musket to one turn in a distance, varying from 20 inches to 78 inches, according to the rifle used, yet there seems to be reason for believing that the degree of turn, or the distance within which a complete spin takes place, constantly lessens from the time the projectile quits the muzzle of the musket, owing to the greater

The *number of wounds* in battle will mainly be determined by, *Firstly*, extent of range, and *Secondly*, lowness of trajectory. In the case of two opposing forces armed with cylindro-conoidal projectiles, that force which is armed with the weapon of greatest extent of range combined with the lowest trajectory, *cæteris paribus*, will obviously, so far as small arms are concerned, have the opportunity of inflicting the greatest number of wounds.

Comparison between the probable Surgical-Effects of the Whitworth and Enfield Projectiles in War.

I applied for information on the following points to the School of Musketry at Hythe.

1st. The velocity of the Whitworth rifle ball as compared with the Enfield rifle ball; the conditions as to weight, charge of powder, &c., being equal.

2nd. The hardness of each projectile.

3rd. The exact measurement of each projectile, as to diameter and length.

4th. Which projectile has the more pointed apex.

5th. Which projectile travels in the lowest trajectory.

I have now received replies to these queries from Captain McKay, Deputy Assistant Adjutant-General, dated Hythe, 24th December, 1862.

From these replies I learn that experiments have been made with the two forms of the Whitworth projectiles, viz:—the cylindro-conoidal and the hexagono-conoidal, and that a comparison between, firstly, the Enfield and Whitworth *cylindro-conoidal* projectiles, as to the points above named, gives the following results.

1st. The velocity of the Whitworth rifle ball, under the conditions named, exceeds that of the Enfield, at a distance of 800 yards, in the ratio of 6 to 4, taking penetration as a test of velocity. Its range, or area of destructive power, is therefore increased; the increase being in proportion to the increase in velocity. Its destructive power on meeting opposition is increased. This power will exceed that of the Enfield as the ratios of the squares of their respective velocities exceed each other.

2nd. The hardness of the two are alike, both being made of lead only.

3rd. The measurements are:—

Enfield cylindro-conoidal, length 1·15 inch, diameter ·55 inch.

Whitworth cylindro-conoidal, length 1·460 inch, diameter ·442 inch.

4th. The Whitworth has the more pointed apex, in consequence of its reduced diameter.

5th. The Whitworth projectile has the flatter trajectory, especially at long distances.

Taking these data as a basis, it follows, as a necessary consequence, in accordance with what I stated to be the conditions in projectiles which chiefly influence their power of wounding the human body, that—

1stly. The Whitworth cylindro-conoidal ball would be calculated to inflict more wounds when directed against a given body of troops than the Enfield cylindro-conoidal projectiles; and—

2ndly. That the Whitworth cylindro-conoidal ball would afford the opportunity of inflicting a greater number of wounds over an extended field of battle than the Enfield cylindro-conoidal ball.

Next, as regards comparison between the Whitworth *hexagono-conoidal* projectile and the Whitworth *cylindro-conoidal* projectile, I am informed by Captain McKay that the hexagono-conoidal projectile has one-tenth of tin in its composition; that its hardness and power of penetration are thereby rendered greater; that its diameter is greater by reason of the projecting angles, and that its trajectory is still flatter than the Whitworth cylindro-conoidal projectile.

With these data as a basis, therefore, it will follow that the conclusions

opposition to the forward motion than to the spinning motion in its passage through the air. At any rate, when the forward motion is stopped, or nearly stopped, by a substance capable of opposing sufficient resistance, the shortened turn is in certain cases rendered obvious to sight, and it is under such circumstances that the fact is of importance to surgeons.

arrived at respecting the power of wounding, and probable number of wounds, from the action of Whitworth cylindro-conoidal bullets, as compared with the action of Enfield rifle bullets, will hold good in a stronger degree if the Whitworth hexagono-conoidal be compared with the Enfield cylindro-conoidal projectiles.

The hardness and flatter trajectory are the chief ingredients in effecting this increase, not the difference in form: the softer cylindro-conoidal Whitworth projectile is hexagono-conoidal when it leaves the rifle, and, if not altered by accident, is also so at the time of striking the body.

The initial power of penetration of this hardened projectile is stated to be as 35 to 12, compared with that of the Enfield projectile. In other words, if at a distance of 50 yards the Enfield ball would go through two men at the same distance, *cœteris paribus*, the Whitworth would pass through six men.

Remarks on the probable efficiency of the Prolonged Whitworth Projectiles as regards the severity of Wounds inflicted by them.

It is understood that the purpose of a military commander in war is, not to destroy as many lives as possible, but to render as many opponents as he can hors de combat. He does not require the "stopping" quality in a projectile, which the sportsman wants in chasing swift animals, or those of a savage kind that might prove dangerous if not stopped or killed; if he did he could have many better projectiles for his purpose than the prolonged cylindro-conoidal rifle bullets. His object is merely to inflict as great a number of wounds as possible, which wounds shall disable the subjects of them for at least the campaign then in progress.

I have already enumerated the qualities required in projectiles to enable them to effect this object, so far as *number of wounds* is concerned, and expressed my opinion that the Whitworth prolonged projectiles possess the qualtiies in a high degree compared with other projectiles.

I will now briefly consider the character and *probable severity* of the wounds they will inflict.

It will be convenient, in estimating the probable severity of the wounds which would result from the use of the Whitworth projectiles (and for all practical purposes, the two forms of projectiles may be spoken of together) to divide the parts of the body exposed to their fire, into the head and trunk, and the upper and lower extremities.

The head and trunk may be spoken of together. The increased velocity of the Whitworth projectiles increases their power of penetration proportionably with the square of that velocity. This accelerated force, combined with their form, will cause them to penetrate, or perforate, these parts of the body even more frequently than the Enfield cylindro-conoidal bullets, or, in other words, course round, glance off, or become arrested in their progress, by the outer walls of their cavities less frequently; and, with exceedingly few exceptions, such wounds must be fatal in their results. The difference in the diameters of the projectiles will not affect the issues of such wounds: if the head or trunk be penetrated by either projectile it will not matter whether it is half an inch or four-tenths of an inch in diameter. We may therefore expect that the use of the Whitworth projectiles would lead to a greater number of fatal wounds of the head, chest, and abdomen, in war.

The upper and lower extremities may be considered together, so far as *flesh* wounds are concerned. The same causes which have been supposed to lead to a greater proportion of penetrating wounds in the head and trunk, act in producing a greater number of direct perforating flesh wounds. These, as a general rule, when the projectiles causing them had preserved their original course of rotation, would perhaps be less serious, because less tedious in their consequences, than flesh wounds in which the projectiles from diminished velocity had pursued a more indirect and devious course after entering a limb. But the average length of time for the cure of such a wound, even when no nerves or other important structures had been involved in the injury, would be seven or eight weeks, and for this period the soldier would be removed from active service. As regards the special condition before mentioned of the original line of rotation on the long axis being changed into a partial rotation on one of the short axes, the greater amount of destruction might be looked for, *cæteris paribus*, from the mixed tin and lead projectiles; because, from their hardness, such projectiles would be less likely to be flattened on meeting with bones, and they would therefore, after striking them, preserve their full length in their continued rotating course through the soft tissues.

In considering the upper and lower extremities, so far as injuries to their *bones* are concerned, wounds of the thigh, leg, and foot, are so much more serious than those of the arm and hand, that they can hardly be considered together. But, speaking generally, the qualities of the Whitworth projectiles already mentioned might be expected to lead to a greater number of fractures of the bones. Whether there would be the same amount of dangerous splintering of bones with the prolonged projectiles as with the Enfield cylindro-conoidal, can hardly be decided without practical experiment; but this appears to be more a matter of professional interest, as far as surgical treatment is concerned, for any kind of gunshot fracture of bone will answer the military object of disabling the wounded soldier for several months, if not altogether, for further service.

The general conclusion is, therefore, if elongated projectiles, such as the Whitworth projectiles, were substituted for the Enfield projectiles in war, that,—

1stly. The number of head and trunk wounds would be greatly increased; the amount of increase being proportionate to the greater velocity and lower trajectory of the Whitworth *cylindro-conoidal*, and to the greater velocity, lower trajectory, and greater hardness of the Whitworth *hexagono-conoidal* projectile.

2ndly. That of these wounds a greater proportion than now usually happens in war would be attended with fatal results on the field of battle.

3rdly. That there would also be, in like proportion, a greater number of fractures of bones, as well as of flesh wounds of the extremities, but the comparative degree of severity of these can hardly be stated without further experience.

PRINTED BY HARRISON AND SONS, ST. MARTIN'S LANE.