HIGH VELOCITY GUNSHOT WOUNDS OF THE CHEST†

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Die effekte van misiele varieer met spoed en tipe, massa en vlugeienskappe. Nie slegs die grootte nie, maar die gepaardgaande skokgolwe en tydelike kavitasie veroorsaak letterlik ontploffende vernietiging van longweefsel.

Thoracic trauma is conventionally classified as "closed" and "open". Most closed injuries are the result of rapid deceleration — falling from a height (the common building industry accident), crushing (the common mining accident) and high speed traffic accidents (the "steering wheel" injury). The compressive effects of blast can produce injuries indistinguishable from those of rapid deceleration. In civilian life most "open" injuries, in which there is a breach in the chest wall, are less widely destructive; the common injuries are from low velocity missiles and knives. Impalement, say on a piece of picket fencing, may be an accompaniment of high speed accidents, and retention of a transfixing foreign body is then an added therapeutic problem.

The destructive effect of missiles varies with their velocity and the type, weight and flight characteristics of the missile. Velocity — now classified as low, medium and high — was little considered until the introduction of high velocity missiles, and the ready availability to soldiers and urban guerillas of the weapons able to fire such missiles. The damage inflicted by a low velocity (less than 1 200 ft. per sec.) bullet, even at close range, depends more on the type and flight characteristics of the missile than on velocity. Spin, yaw, precession, nutation, tumble— these are all terms used to describe flight characteristics and all modify the extent of tissue damage consequent upon the passage of a missile. Bullets which expand or fragment on impact will clearly also inflict greater damage than those that do not. Notwithstanding, low velocity missiles in general damage the lungs surprisingly little — so much so that it was an aphorism during the 1939 - 45 war that, if to be shot was unavoidable, it was preferable to be shot in the chest, especially in the right half of the chest.

Different are high velocity injuries. High velocity missiles (those that travel at a speed greater than 1 500 ft. per sec.) even if of small calibre, produce an entirely different range of injuries related directly to the speed of the missile through tissue. To the lacerating and crushing effect of impact and the physical transit of the missile through tissues are added the destructive effects of both shock waves and temporary cavitation, and missiles of a velocity of 4 - 5 000 ft. per second produce temporary cavitation of literally explosive destructiveness.

On impact, a missile compresses the medium struck and this region of compression disperses as a *shock wave* of spherical form, with a velocity slightly greater than that of sound in water (4 800 ft/sec) — that is, its advance through tissues is that of the higher velocity missiles. Shock waves are both transmitted through and reflected from interfaces in their path, so that pressure changes at any one point may, by augmentation or cancellation, be very complex. Pressure changes produced by shock waves are of short duration (15 - 25 milliseconds) but may reach 1 000 lb/sq. in. With the passage of high velocity missiles through tissues in which vital organs are not directly struck, shock waves are likely to bounce off bone but can be very damaging to the gas containing viscera — gut and lung.

As a missile penetrates it accelerates the medium struck, forwards and laterally, with such force — and the greater the velocity of the missile the greater the force — that the composite particles of the medium or tissue, consequent upon their inertia, continue to be displaced away from the path of the missile for several milliseconds after the missile has traversed the body, so that the missile tract (defined as the *permanent tissue defect* in the path of the missile), is expanded into a cavity, called the *temporary cavity* (defined as the tissue defect at the instant of missile flight through the tissue), which collapses quickly. Pressure in the temporary cavity is subatmospheric and contents include vapour from the tissues traversed and entrained air. The size of the permanent tissue defect depends on the volume of tissue lost through entrance and exit wounds and the volume of air trapped when the temporary cavity finally collapses, which it does in a series of expansions and contractions of diminishing amplitude. The size of the temporary cavity and the number of pulsations or volume changes induced depend on the velocity of the missile, but pulsations may extend over more than 20 milliseconds and the temporary cavity may be more than 30 to 40 times the volume of the permanent cavity. At velocities below a 1 000 feet/sec. temporary cavitation is of little moment. At high velocities temporary cavitation is very much more damaging than are shock waves.

Negative pressure in the temporary cavity may suck in clothing and other debris. Pulsation may extrude tissue from the entrance wound — an eversion phenomenon called tail splash. At the higher velocities of missile traverse through tissues, the rapidity and the extent of expansion of the temporary cavity may be so violent that the elasticity of adjacent structures may not be able to contain it and the effect is explosive and implosive, mimicking the use of explosive bullets. Thus, the passage of a high velocity bullet through the head will explode the skull; through the abdomen, will explode gut; and through the chest, will explode lung. And while the early radiographic features of lung damage — pneumothorax, haemothorax, and pulmonary haematoma — may be little different from those produced by low velocity missile, the passage through the lung of a high velocity missile so disrupts the lung over so wide an area that radiographic evidence of damage is ingravescent and the need regularly arises for pulmonary resection, essentially for removal of irreparably damaged pulmonary itssue wrenched from its blood supply.

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