EDITORIAL

The Idolatry of Velocity, or Lies, Damn Lies, and Ballistics

She tangled with a washing machine—and lost. It was clear that she had suffered a greater injury than the obvious posterior dislocation of the elbow: neither the radial nor the ulnar pulse was palpable. An emergency reduction was in order after a quick radiographic screen. While the exposure was in progress she developed tense, cystic swellings both above and below the antecubital fold. After reduction the pulses at the wrist were still not palpable, but were faintly detectable by Doppler measurement. At exploration the brachial artery was found to be cleanly severed, but both ends were contused, and resection and grafting were required to restore continuity.

The lesion seen in the vessels has been described as characteristic of high-velocity missile injury, but a washing machine rotor is a low-velocity (albeit high-mass) agent.

The pages of this *Journal* are replete with references to the importance of velocity in missile wounds:

Wounding power is equivalent to $\frac{MV^2}{2}$.

Velocity is the dominant factor.

The greater the striking velocity the larger the temporary cavity.

The larger the temporary cavity the more debridement is required.

The high-velocity M-16 rifle was designed to, and does, produce a more severe wound.

Not so.

On occasion I am called upon to testify as an expert in wound ballistics. Once I have been sworn I cannot use a single one of the above statements. None is completely false, but not one of them is the whole truth, and nothing but the truth. Nor is the familiar statement true that 'the wound of exit is larger than the wound of entrance.' Often it is, say 60% of the time, but this has nothing to do with velocity; after all, the bullet is travelling slower when it goes out than when it goes in.

$\frac{MV^2}{2}$ is the formula for kinetic energy, not wounding power. I know of nothing in the laws of physics that says that wounding power must correlate with kinetic energy. It could, perhaps, correlate with MV = momentum, or $\frac{MV^3}{2}$ = power. Or it could be somewhere in between, which it is.

Our extensive work at Edgewood Arsenal on the incapacitating effect of various mass-velocity combinations was principally devoted to wounds of the extremities and trunk. The best approximation turned out to be $\frac{MV^{1.5}}{2}$. Recent work in German has determined that in penetrating craniocerebral wounds the effect of velocity is *greater* than the square; let us accept $\frac{MV^{2.5}}{2}$ for the time being.

Even if we use $\frac{MV^2}{2}$ as a crude approximation overall it by no means follows that velocity is the dominant factor in the equation. True, if you are drawing formulas on the blackboard, doubling the mass doubles the kinetic energy, while doubling the velocity quadruples the kinetic energy. Doubling the velocity is hard to do in practice (the vaunted M-16 represents an increment in velocity of only 12% over the M-14 it replaced), but quadrupling the mass is easy. Switch from a .22 to a .44 and you immediately square the mass, then double the length of the bullet so that it flies better, and you now have an eightfold increase in kinetic energy at the same velocity.

Look at any tabulation of rifles which are likely to be employed in combat anywhere in the world today and you will find the M-16 at or near the bottom in kinetic energy (just ahead of the M-1 carbine, which is essentially a long-barrel, shoulder-fired pistol). At or near the top is the 1898 model 8-mm Mauser. The M-16 was designed because the genes of Sergeant York died out. Not only is the average American unable to shoot straight, he won't shoot at all unless the target is close. So we had to develop a spray gun. That meant more rounds, so the rounds had to be lighter, which means that it is easier to push them out at a high enough speed to produce an 'adequately incapacitating' wound.

The mystique of the temporary cavity needs exploding. It is nothing more than simple mechanical displacement of tissues, entirely analogous to the displacement which occurs when a knee is banged up by a bumper, or when an elbow tangles with a washing machine. The orthopedic surgeon does not feel compelled to whack away merrily at a contused quadriceps when he is nailing a closed fracture of the femoral shaft, even though the kinetic energy absorbed is great, and the mechanical displacement involved is considerable. Neither is there any reason to debride a temporary cavity. No one has yet determined what a minimum adequate debridement is for any wound. From our studies on untreated pistol and rifle wounds at Edgewood, from tissue culture studies of samples taken from wound tracts, and from post-shooting angiograms it would appear that a few millimeters around the *permanent* wound tract is all the debridement required. Certainly the debridement should be limited to the damage objectively demonstrable, and not extended on the basis of testimony as to the velocity of the missile.

What is the evidence that patent and occult vascular damage in missile wounds is velocity dependent? The answer: studies of a 1-gram missile fired at 300, 600, and 900 meters per second. Of course! Keeping the mass constant, and doubling or tripling the velocity will produce markedly greater damage, but go back and try the same experiments with missiles of 2, 4, 8, 16, and 32 grams. Or with a washing machine agitator.

If your results come out far off from $\frac{MV^{1.5}}{2}$ considering both velocity *and* mass, please let me know. Meantime I will keep on treating the *wound*, not the weapon.

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