D45 Velocity and Location Effects on Bruises Created Using a Controlled Ballistic Elastic-Mass Delivery System

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After attending this presentation, attendees will be educated on the effects of ballistic impact velocity and anatomical location on the immediate onset, size, duration, and color of bruises created on the thorax and abdomen of volunteers.

This presentation will impact the forensic science community by using bruising biomechanics to assist emergency room physicians in determining cases of possible physical abuse and forensic investigators in estimating the timing of recent blunt-impact injuries.

Existing literature contains conflicting information regarding the color changes in bruises with respect to time. There is general agreement that the first colors seen are usually deeper reds, black, and blue. Yellow is generally not seen for the first 18 – 24 hours, but after that, any color may be present. It follows that deeper tissue bruises, from higher-velocity impacts, will remain darker, longer. It is hypothesized that if mass is constant, a bruise from a slower impact will resolve more rapidly, have a smaller area with color change, and include lighter colors.

The relationship between velocity and bruise characteristics has not been thoroughly explored in published literature. Specifically of interest is the effect that impact velocity has on the affected area of color change (as measured at the point of impact and at 10, 20, and 30mm from the point of impact) as well as the magnitude of the color change. The effect of bruise location was also investigated.

Forty healthy adult volunteers completed an initial questionnaire to screen for bleeding disorders and blood thinning medications. Informed consent was garnered, and each subject had their thoracic and abdominal regions digitally photographed (Canon EOS 30D, Lake Success, NY). Prior to bruise creation, tri-stimulus light reflectance was also measured using a commercially available colorimeter (model CR-400, Konica Minolta) tri-stimulus light reflectance was reported using the three-dimensional CIE 1976 (L*, a*, b*) color space, where L* represents luminance (0 = black, 100 = white), a* represents the shift from magenta to green (green is indicated with negative values, magenta with positive values), and b* represents the shift from yellow to blue (blue is indicated with negative values, yellow with positive values). Changes in the CIE 1976 color space are represented by ΔL*, Δa* and Δb*. The overall change in the CIE 1976 space is characterized by the value ΔE, which is the vector sum or resultant of the three color space change variables ΔL*, Δa*, and Δb*.

Blunt impact injuries were inflicted using a pneumatically-fired system. The impacting projectile was a standard .68 caliber paintball, spherical in geometry with a mass of 3.1 grams. Impact velocities were either approximately 200ft/sec or 300ft/sec and impact energies were 5.75 J and 12.95 J respectively. Both body regions on each subject received impacts of the same velocity for 29 of the subjects, while 11 subjects chose to stop or the gun malfunctioned for one of the shots. The first shot location was varied randomly between two body regions and the shot velocity was varied randomly between subjects. Baseline measurements at both impact sites were compared to measurements taken immediately after impact, as well as 60, 90, and 120 minutes post impact. These measurements were taken at the point of impact and at 10, 20, and 30mm from the point of impact.

A repeated-measures analysis was performed for the 29 subjects that were impacted in both locations (SPSS version 19, IMB). A within-subjects comparison included the ΔE differences at: each body region, all four distances from impact, and all four time periods; and a between-subjects analysis was performed for the impact velocity. The color change was significantly greater at the higher impact velocity $F(1, 27) = 31.4$, $p < .05$. There was no significant difference in the color changes measured at the thorax compared to the abdomen $F(1,27) = 0.949$, $p = .339$. There was a greater color change immediately after impact when compared to all other times $F(1, 27) = 49.151$, $p < .05$. The color change decreased significantly at each increment of distance away from the point of impact $F(3, 25) = 50.697$, $p < .05$.

Bruising, Velocity, Quantification

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